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ASSESSMENT OF SENSORY TECHNIQUES FOR QUALITY ASSESSMENT OF AUSTRALIAN FISH

by

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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ABSTRACT

Accumulation of demerit points with time of storage of blue grenadier (*M. novaezelandiae*) in refrigerated sea water (RSW) and blue rock whiting (*H. semifasciata*) in ice was found to be highly correlated and occurred in an approximately linear fashion irrespective of the method of scoring used. The scoring system developed by the TFRU was found to be the easiest, quickest and most reliable method for quality assessment of fish. The changes in the appearance of the eyes and the odour development of the gills are the most obvious and valuable indicators of change in quality when using the TFRU or the EEC freshness scores, while the appearance and odour of the fish flesh seems to be the most obvious indicator when assessing the filleted samples. The acceptability taste panel results indicate that *M. novaezelandiae* stored in RSW had a shelf-life of 14 days whilst *H. semifasciata* stored in ice had a shelf-life of 17 days. The cut-off point at which spoilage of the samples would have rendered the quality of the fish samples to be unacceptable from the consumer point of view would be those equivalent to the accumulated demerit point of >29 for the TFRU (gutted and ungutted) scores and >21 for the EEC and filleted sample scores.

1.00 INTRODUCTION

1.10 Quality and Quality Assessment of Fish

Quality is difficult to define, since it means different things to different people. One general definition is "degree of excellence". According to Waterman (1982), quality of food is the sum of those attributes that govern its acceptability to the buyer or consumer and quality assessment is the estimation or measurement of one or more quality factors as a means of determining quality before exercising control.

Bremner (1984) defined quality as that attitude of mind; that approach, that event, that state of being when everything is right. Thus until a seafood is eaten its 'quality' can only be surmised indirectly; however seafoods do possess a set of properties, or characteristics that for practical purposes can be related with quality.

In commerce, quality limits are set by what the customer is prepared to pay for; generally the customer will pay more for fish that he considers to be of higher quality, and will continue to buy as long as quality remains constant. The relationship between quality and marketing is therefore governed by the sophistication of the consumer (De Zylva, 1974). Some of the more important factors that determine quality from the customer's point of view are species; ease of preparation, appearance; odour; flavour; freshness; size; presence or absence of bones and filth; absence of specific microorganisms; condition; packaging and composition (Connell, 1972).

Freshness is the most important quality factor to the consumer; thus assessment of freshness is vital in quality control. According to Baines et al (1965), the term "freshness" is employed to describe the presence or absence of deterioration. To many, however, freshness involves the concept of "newness" in which time is an important factor. In other words, the fish technologist is not only concerned with quality at the moment of examination but of the product's potential shelf-life. An accurate measure of stowage time under known conditions would allow him to calculate the remaining life of the product and its potential for processing.

Fish quality depends on temperature, time and hygiene. Factors such as spontaneous chemical changes, autolysis and microbial attack produce deteriorations from the point of catching until final putrefaction. Measurements of some of these deteriorations have been invoked as indices of freshness.

The measurement of trimethylamine (TMA), other spoilage compounds and the bacteria themselves as indicators of quality has been reviewed recently by Martin et al (1978). They stated that in order to define effective indicators of seafood quality, the food technologist must "be prepared to examine each species of seafood individually, its environment, its composition, its harvesting and its handling."

A number of different tests may be used for estimating the degree of spoilage in fish; these include: total volatile bases (TVB); total volatile reducing substances; volatile ammonia; volatile acids; total volatile nitrogen; indole; refractive index of the eye fluid; electrical resistance of the fish flesh, total bacterial numbers and organoleptic tests. These methods are discussed under the headings chemical methods, physical methods, microbiological methods and sensory methods below.

1.20 Chemical Methods

Although not universal in acceptance or applicability, the trimethylamine (TMA) determination has become one of the established procedures for determining fish quality. Its use as an indicator of spoilage in fresh fish have also been proposed by the Codex Alimentarius Committee on fish and fishery products (Olley, 1977). This is despite the fact that there is ample evidence that the same amount of TMA is accompanied by different amounts of spoilage even within the same species.

Several investigators (Spinelli, et al, 1984; Jones, 1965) have expressed reservations regarding the use of TMA as an index of quality for fresh fish, noting that TMA values fail to give an adequate indication of early autolytic quality changes and preferring hypoxanthine determinations instead. TMA, as would be expected of a bacterial product, is not useful in determining quality deteriorations which occur during frozen storage. Furthermore, the shape of the fish will markedly influence the amount of TMA measured in mg per 100 g fish (Bremner et al, 1978). Trimethylamine is most sensitive as an indicator of the later stages of spoilage whereas chemical tests for dimethylamine are most valuable in the early stages of spoilage.

Ryder et al (1984) found that the bacterial metabolic end products (TVB and TMA) were less useful as objective measurements of freshness in Jack Mackerel (*Trachurus novaezelandiae*). They also reported that the pH was not a good indicator of early storage changes and TBA values could not be used to determine loss of acceptability or end of shelf-life. Recently it has become apparent that the sulphur compounds, H_2S and mercaptans may be important determinants of fish odour and flavour (Herbert and Shewan, 1975). Measurement of TMA, DMA or ammonia requires a laboratory and assistant of matriculation standard who has had some weeks of practice in the method. Neither the Codex Alimentarius Committee or the EEC (Common Market) lay down sampling procedures.

Another quality assessment measurement involves the nucleotides and their degradation products. Early studies with cod, carp, Pacific Salmon, lemon sole, haddock and plaice revealed that post-mortem nucleotide degradation in fish muscle proceeds primarily via the following sequence of reactions: ATP -> AMP -> IMP -> INO -> Hx -> Xa -> UA where ATP = Adenosine 5-triphosphate, AMP

= Adenosine 5-monophosphate, IMP = Inosine 5-monophosphate, INO = Inosine, Hx = Hypoxanthine, Xa = Xanthine, and UA = Uric acid. Two stages in this degradative sequence have been considered as objective indices of quality - dephosphorylation of IMP, and formation of hypoxanthine. IMP reportedly possesses properties as a flavour enhancer in fish muscle. Consequently, its breakdown may contribute to, and be correlated with the loss of fresh flavour in some species. Some difficulties, however, may arise from using IMP dephosphorylation as a single quality index e.g. the pattern of nucleotide breakdown in invertebrate seafood species may differ in some key respects from that found in vertebrate species. The rate of IMP decomposition in the muscle also differs between species (Ehira, 1976). According to Martin et al (1978), the most serious limitation imposed by an IMP index may be that the reaction is substantially complete well within the edible storage life of a number of species. Its major value then may be as an indicator of fresh flavour loss during early storage.

Unlike IMP, concentrations of hypoxanthine (Hx) have been shown to increase steadily throughout the useful storage life of a number of fish species (Hughes and Jones, 1966). Hypoxanthine formation is a result of both autolytic and bacterial activities. Thus, it also has advantages over the TMA assay. Hx may be correlated with flavour loss caused by autolytic activities during early storage and with bacterial spoilage during extended storage, to derive a prediction of useful storage life. Also, the TMA test is of no value for freshwater fish because these either do not contain or contain very little trimethylamine oxide. Hx may also be used to determine the quality of canned herring at the time of processing, since hypoxanthine concentrations neither increase nor decrease during heat processing and subsequent storage (Hughes and Jones, 1966). TMA concentrations, on the other hand, are unstable during heat processing. However, different species of fish produce hypoxanthine by different routes and at different speeds. Each Australian species would have to be examined in turn and the hypoxanthine test related to sensory grades. Note that the Canadian redfish and flounder had produced the maximum amount of hypoxanthine long before they became unacceptable, while the swordfish had only produced a fifth of the amount when it became unacceptable to a taste panel (Olley, 1978). The hypoxanthine test requires laboratory facilities and some equipment but recently the use of simple paper strips have been reported (Jahns et al, 1976).

The main disadvantages of nucleotide assays are that they are apt to vary even among individuals within a species. Sufficient samples need to be used to reduce this variability.

All the chemical methods discussed above depend on measuring the concentration of certain chemical substances in the flesh and since the sample is destroyed in the process, they cannot be used to test every fish in a batch. In any case, variation between fishes in the same batch makes chemical tests for quality a task requiring a statistician (Olley, 1977). All the methods require the use of a laboratory or fairly elaborate facilities and also they do not apply to all species and products alike.

1.30 Physical Methods

Love (1954) described a method which correlates the turbidity of the eye lenses of fish with storage time of iced fish kept in a room of fairly constant air temperature. He found that it is possible by examination of 20 or more lenses to assess the storage time with an error of not more than 1 day. An advantage of this method is that since only the eyes have to be removed in sampling, the fish remains saleable as headed, dressed fish or as fillets. However, the method had many limitations such as difficulty in manipulation and matching of the lenses which have to be done in good diffused daylight, at least 20 lenses are required for each estimation which is rather tedious for routine work and also it is not applicable where fish had not been kept all the time in ice under the standard conditions, e.g. bulk stowage of fish with ice on a trawler may result in deviation from the conditions of box stowage in an insulated room.

The GR Torrymeter is a battery powered hand-held instrument that measures certain dialectric properties of fish skin which change with the time/temperature history of the fish. However, readings on a large number of samples have to be taken and averaged. Although it is a rapid, simple, objective and non-destructive method of estimating the quality of fresh fish, it has the following disadvantages; large variation in reading from fish to fish; reading varies with physical damage to fish; change of reading with time varies with species and also may be insensitive at later stages of spoilage. Curran et al (1981) reported that the GR Torrymeter was not particularly successful with both the purple emperor (*Lethoinus lentjan*) and the Spanish mackerel (*Scomberomorus commerson*) since the readings obtained do not correlate very well with the taste panel results.

1.40 Microbiological Methods

The routine microbiological testing that is performed under normal industry operations is normally restricted to enumeration of nonpathogenic microorganisms. Those most frequently used are the standard plate count and enumeration of indicator organisms such as the coliform group, *Escherichia coli*, and *Staphylococcus aureus*.

Food handling practices beyond the primary processor's control make standard aerobic plate count (APC) a difficult quality assessment tool to use generally. The total number of bacteria is not the sole determinant of quality, since certain microbial groups are more apt to cause spoilage than others. These groups can be given a selective advantage for growth by the way the product is processed or stored. Furthermore, the determination of bacterial counts, while they are of value to research requires too much time before results are known and can also be expensive for routine testing. Representative samples have to be taken for bacterial examination because the fish or product is destroyed during the test. Interpreting the results of bacterial testing is a task for experts who should be consulted when necessary.

Detection and enumeration of indicator bacteria such as the coliform group, *E. coli* and *S. aureus* were considered for many years to indicate the potential presence of pathogenic microorganisms. Now, this inference has been questioned and these groups are no longer considered a reliable method for predicting the presence of such pathogens (Martin *et al.*1978).

According to Olley and Ratkowsky (1973), there is in fact no simple index of quality and a thorough knowledge of the complete temperature history of the fish is the only true indicator of freshness. This is so because at higher temperatures bacteria divide in half more rapidly. Therefore, the relationship between bacterial growth with production of spoilage compounds and temperature is not a straight line but a curve. The curve relates rate of spoilage of these commodities at temperatures between 0°C and 25°C to the rate at which they would spoil at 0°C. Thus at 0°C the relative rate is 1 and at any other temperature the relative rate is $\frac{\text{Rate at temperature } (t\,^\circ\text{C})}{\text{Rate at } 0\,^\circ\text{C}}$. Bremner *et al.* (1978) have coined the term ICE FOLD for this relative rate i.e. "so many times faster than the commodity would spoil on ice", and ICETIME as equivalent storage time on ice = ICEFOLD x time in days. The curve has also been converted into tabular form to enable conversion of the temperature history of the catch into equivalent storage time on ice under ideal conditions. However, the concept of relative rate of spoilage with temperature can only apply if fishing conditions are kept constant.

1.50 Sensory Methods

Currently the best way to determine fish freshness still requires the use of a taste panel (Regenstein and Regenstein, 1981). A number of taste panel techniques for assessing the quality of unfrozen fish species have been described and are in use in different parts of the world. These techniques vary in objective and complexity but are of three main types. Firstly, there are those which categorise the fish on the basis of its acceptability for eating. Secondly, there are those which categorise the fish on the basis of well-defined characteristics which change during storage. Thirdly, there are techniques which include elements of both of these types. Techniques of the first type usually employ a single grading or hedonic (like-dislike) scale, whilst those of the second type employ descriptions of various characteristics (Baines et al, 1969).

The ultimate criterion of fish quality is the flavour and texture of the cooked fish. However, taste panel evaluations of cooked fish are time-consuming, and relatively few samples can be tested at any one time. It is therefore highly desirable to be able to make an assessment of eating quality by examining the raw fish. Any attempt to raise the quality of raw fish as it reaches the consumer is critically dependent on the development of a convenient and consistent method of quality assessment based on raw fish. Fortunately, eating quality of cooked fish can be correlated with the appearance, odour, and texture of the whole raw fish. Boyd and Wilson (1976) when evaluating the quality of snapper (*Chrysophrys auratus*) by a sensory method found that there is close relationship between the raw attributes of gill odour and general appearance with those of odour, texture, and flavour of the cooked fish.

The use of objective tests at dockside or even on inspection within the plant is not considered to be practical in the normal routine of inspection of fresh and frozen fish products, as almost all of the objective tests require laboratories and so become rather removed from the busy fisherman, processor or factory foreman. A much simpler piece of apparatus is the eye or the nose (Olley, 1977). Sensory tests are always controversial as they require an inspector, although the canny buyer is in fact applying his senses of smell and visual acuity in a similar fashion. "We accept the wine faster and wool classer, so why not the fish grader" (Bremner 1984). Therefore a test that correlated well with freshness/quality and that could operate on the market or in the factory would be of considerable value to an efficient industry (Baines et al, 1965).

Howgate (1978) also considered the sensory methods to be far better than non-sensory methods which are not suitable for consumer testing, whilst Connell (1972) states that in general, the sensory method of assessing freshness is the best at present for quality control purposes.

As fish spoils, its smell, taste, appearance and feel go through characteristic and well defined stages that trained experts or experienced staff can consistently recognise. It is convenient to attach a number or score to each stage so that the assessor can award the appropriate score to each fish or batch of fish. Alternatively the mere recognition of each stage, and acceptance or rejection of fish on this basis, may be all that is necessary. Different species and products spoil in different ways. The numerical system using an objective panel developed at the Torry Research Station by Shewan et al (1953) is probably the ultimate critical evaluation of fish freshness available at this time. It was created for the determination of storage time of whole wet fish. Regenstein and Regenstein (1981) in using this numerical system reported that the cooked freshness scores are generally higher (better) than expected at that storage time for whole wet fish. A freshness score of 5.5 on the Torry scale seemed the appropriate endpoint for their definition of shelf-life. This would normally be reached with ideal iced-at-sea fish about twelve days from catch, sooner for fillets. Freshness scoring systems are now available from Torry Research station for most U.K. commercial species and systems are available for both the raw and cooked fish. However, there is still no standard scoring system to be used internationally. The countries in the EEC for instance, use scoring systems which differ both in scale length and in characteristics measured. Most systems use the same scale length for all features examined but the United Kingdom and Iceland use scales of 10 to 0 for odour and 5 to 0 for other characteristics. Howgate (1972) describes the effort to construct a nomogram for converting from one scoring system to another (Appendix 1). de Zylva (1974) expanded the Torry score sheet to include marks for flesh colour and texture, belly flap discoloration, staining of backbone and colour of kidney. The scoring system was designed for New Zealand snapper and gave excellent negative linear correlations between score and days of storage. Regenstein (1983) presents the way in which Torry has in turn incorporated other characteristics into the score sheet for raw fish. Groupings of several characteristics to give a score requires more expertise than scoring individual points as is done by de Zylva.

However, the use of a point or scoring system in which higher points are given for high quality attributes would mean the requirements of more knowledge of the fish and the tester must be experienced and know the qualities of the fish previously. Therefore it is too species dependent. This problem can be overcome by using the demerit system with points being allotted in several categories for defects as they become obvious and one can learn as one goes along in each situation. The demerit points that were given to the various selected quality attributes could be weighted in such a way as to produce an approximately linear change in score with storage time (Branch and Vail, 1985).

It might also be desirable commercially to specify a uniform number of days of shelf-life from the pack date to consumption. The length of shelf-life obtained for fish depends on the initial age and quality of the fish, the time of the pack, and the time and temperature of storage before and after packing. In practical terms, the ultimate measure of the effect(s) of shelf-life extension treatments on the final quality of the fish is consumer satisfaction (Regenstein and Regenstein, 1981).

A tentative grading system for fresh fish based on sensory assessment of fish had been described by Houwing (1972).

1.60 The Ideal Method

Forty years of research, notably in the UK, Canada and Japan, have gone into objective methods for measuring fish quality (Bremner et al, 1978). There is, as yet, no single universal test for all species, nor for that matter any wholly satisfactory test for individual species.

The ideal method would be one that is cheap, non-destructive, easy to use, not subject to much variation, or fatigue, having rapid response and wide application. Sensory tests have the advantages of being non-destructive, no equipment required, adaptable to species and assessing the market value. Although sensory tests are usually condemned as a subjective test which requires training and experience, and are also said to be easily open to abuse, this can be reduced if a simple, rapid and less descriptive method could be found - possibly with the use of demerit point scores. Therefore this study aims at assessing the use of sensory techniques based on the demerit point scores developed for raw whole (gutted and ungutted) and filleted fish samples of Australian fish species stored in ice and RSW. It also discusses the results of the acceptability taste panels on the cooked fish samples.

The two commercially important Australian fish species used in this study were the blue grenadier and the blue rock whiting. The blue grenadier is currently Tasmania's major commercial finfish and the recent annual production of the fishery exceeds 100 tonnes (Last et al, 1983). The blue rock whiting is the only Australian member of the family that has any commercial importance. It occurs mainly in Bass Strait and the sheltered bays of South eastern Tasmania. The flesh is delicately flavoured but very soft.

2.00 MATERIALS AND METHODS

2.10 Sample preparation

2.11 Fish stored in RSW

Blue grenadier used in this study were caught on the 15th August 1984 at a depth of 300 fathoms off Sandy Cape on the west coast of Tasmania (Lat. 41°20'S Long.144°40' E.) by demersal trawl. They were taken from the deck immediately and dropped into a refrigerated seawater (RSW) tank in a net bag (temp. -1°C). The fish was reported to be handled quite roughly on board. Some of the fish had already gone into rigor at this stage. The fish were transported to the CSIRO Tasmanian Food Research Unit (TFRU) laboratories in Hobart and were already two days old on arrival. The fish were then placed in the RSW box tank of the mobile unit (the design and construction of which were described by Thrower and Stafford, 1981) and was kept at -1°C for the duration of the storage trial which lasted for about three weeks. Four fish were removed at each sampling time (Table 1) for sensory assessment. Length measurements to the fork of the tail were also noted. The fish were then filleted and samples frozen at -18°C for later assessment of their acceptability by taste panel.

2.12 Fish stored in ice

For the sensory assessment of fish stored in ice, guidelines similar to those given by Lima dos Santos et al (1981) were used. The blue rock whiting, also known as the weedy whiting was used. The whiting were caught on the afternoon of 23rd August 1984 by demersal trawl in 18 to 25 m waters off Eastern Tasmania. On arrival at the TFRU laboratories in Hobart at 11.45 am on the following day, the fish were re-iced at a ratio of 2:1 (ice:fish) in insulated plastic boxes of size 66 x 41 x 28 cm, with provision for drainage of melt water. Flake ice was used. The ice was topped up daily and renewed once a week. The boxes of iced fish were then kept in a cool room set at a temperature of 0° to -1°C. Three fish were removed for sensory assessment at each sampling time (Table 1) over a period of more than three weeks of ice storage. The fish samples were then frozen at -18°C until needed for the acceptability taste panel.

Table 1

Sampling regime for fish stored in RSW/ice

Blue Grenadier	Days in RSW	3	4	6	8	9	10	11	12	13	14	17	21
	Sample code	N	D	G	L	S	R	K	T	U	P	M	O
Whiting	Days in ice	1	3	5	7	9	11	13	15	17	19	21	23
	Sample code	O	M	D	G	T	S	N	R	P	U	L	K

2.20 Sensory assessment of the whole (gutted and ungutted) raw fish samples

Both the blue grenadier stored in RSW and the whiting stored in ice were progressively assessed by using the sense organs of sight, smell and touch for changes in general appearance, odour and texture with storage time by giving the appropriate demerit scores according to the score sheets as shown in Tables 2 and 3. Two types of score sheets were used. Table 2 shows the sensory assessment score sheet originally developed for the assessment of gemfish (Thrower et al, 1982). It has been simplified and weighted (Branch and Vail 1985) to provide accumulated increases in demerit points as the fish change in odour, texture and appearance during storage with the maximum accumulated demerit point scores of 35 for the ungutted samples and 39 for the gutted samples. The total scoring for gutted fish differs from that described by Bremner (1984) and Branch and Vail (1985) in that the demerit points for the belly cavity have been added to those for the whole fish.

The whole and gutted raw fish were also assessed by using the freshness score sheet developed by the Council of the European Communities (Official Journal of the European Communities, 1970) but with slight modification made in its scoring method in that the scoring was reversed to provide accumulated increases in demerit points as in the TFRU score sheet (Table 2), with a maximum accumulated demerit score of 30 (Table 3). The samples were scored by H. Abd. R. who had had no previous experience with the score sheet.

2.30 Sensory Assessment of the frozen, filleted raw fish samples

Samples of the whole and gutted fish of both species were then filleted and frozen at -18°C until required for the organoleptic acceptability test panel, fillets were thawed by holding for about 16 hours (overnight) in still air at 4°C. The thawed fillets of both the blue grenadier and whiting were then assessed by the sense organs of sight, smell and touch by using the score sheet for filleted sample as shown in Table 4. The score sheet was developed

Table 2

TFRU Sensory assessment score sheet
(GUTTED AND UNGUTTED)
SAMPLES

FISH IDENT.			
APPEARANCE		(V.Bright/Bright/Sl.Dull/Dull	0 1 2 3
SKIN		(Firm/Soft)	0 1
SCALES		(Firm/Sl.Loose/Loose)	0 1 2
SLIME		(Absent/Sl.Slimy/Slimy/V.Slimy)	0 1 2 3
STIFFNESS		(Pre-Rigor/Rigor/Post-Rigor)	0 1 2
EYES	Clarity	(Clear/Sl.Cloudy/Cloudy)	0 1 2
	Shape	(Normal/Sl.Sunken/Sunken)	0 1 2
	Iris	(Visible/Not Visible)	0 1
	Blood	(No Blood/Sl.Bloody/V.Bloody)	0 1 2
GILLS	Colour	Characteristic (Sl.Dark) (V.Dark) (Sl.Faded) (V.Faded)	0 1 2
	Mucous	(Absent/Moderate/Excessive)	0 1 2
	Smell	(Fresh Oily) Fishy/Stale/Spoilt (Metallic,Seaweed)	1 2 3
BELLY	Discoloration	(Absent/Detectable/Moderate/Excessive)	0 1 2 3
	Firmness	(Firm/Soft/Burst)	0 1 2
VENT	Condition	Normal (Sl.Break) (Excessive) (Exudes) (Opening)	0 1 2
	Smell	(Fresh/Neutral/Fishy/Spoilt)	0 1 2 3
BELLY CAVITY	Stains	(Opalescent/Greyish/Yellow-Brown)	0 1 2
	Blood	(Red/Dark Red/Brown)	0 1 2

TABLE 3

EEC SENSORY ASSESSMENT SCORE SHEET

SCALE OF MARKING - FRESHNESS

Parts of the Fish to be inspected	CRITERIA			
	Assessment Marks			
	0	1	2	3
	Appearance			
Skin	Bright iridescent pigmentation; no discolouration; mucus aqueous, transparent	bright pigmentation but not lustrous; mucus slightly cloudy	pigmentation in the process of becoming discoloured and dull; mucus milky	([1]) dull pigmentation mucus opaque
Eye	convex (bulging); cornea transparent, pupil, black, bright	convex and slightly sunken; cornea slightly opalescent; pupil, black, dull	flat; cornea opalescent: pupil opaque	([1]) concave in the centre; cornea milky; pupil grey
Gills	shining colour, no mucus	less coloured a few traces of clear mucus	becoming discoloured; mucus opaque	([1]) yellowish mucus milky
Flesh cut from abdomen	blueish, translucid, smooth, shining, without any change in the original colour;	dull, velvety, waxy colour slightly changed	slightly opaque;	([1]) opaque
Colour along the vertebral column	uncoloured;	slightly pink	pink	([1]) red
Organs	kidneys and residues of other organs bright red, the same as the blood inside the aorta;	kidneys and residues of other organs dull red; blood becoming discoloured	kidneys, residues of other organs and blood pale red	([1]) kidneys, residues of other organs and blood brownish

([1]) or in a more advanced state of decay

(cont'd.)

SCALE OF MARKING - FRESHNESS

	CRITERIA			
	Assessment Marks			
	0	1	2	3
	Physical condition			
Flesh	firm and elastic surface smooth	less elastic	slightly soft (flaccid) less elastic; surface waxy velvety and dull	(1) soft (flaccid) scales easily detached from skin, surface rather wrinkled, inclining to mealy
Vertebral Column	breaks instead of coming away	adherent	slightly adherent	(1) not adherent
Peritonium	totally adherent to the flesh	adherent	slightly adherent	(1) not adherent
	Smell			
Gills, skin; abdominal cavity	seaweed	not of seaweed but not bad	slightly sour	(1) sour

(1) or in a more advanced state of decay

Table 4

Filleted Sample Score Sheet

TREATMENT FILLETS (THAWED)	DATE	REMOVAL
FISH IDENT.		

EASE OF FILLETING (Easy/sl. difficult/difficult)
0 1 2

APPEARANCE: (a) Colour of flesh: (Translucent/Sl discoloured/Sl opaque/opaque)
0 1 2 3

(b) Blood stains: (Absent/Detectable/Moderate/Excessive)
0 1 2 3

(c) Clotting: (Unclotted/Sl.clotted/Mod.clotted/Excess.clotted)
0 1 2 3

(d) Skin Colour: (V.bright/Bright/Sl.dull/Dull)
0 1 2 3

TEXTURE: Firm/Sl. soft/Soft
0 1 2

ODOUR: (Fresh/Neutral/Stale/Spoilt)
0 1 2 3

CONDITION: (a) Gaping: (Absent/Detectable/Moderate/Excessive)
0 1 2 3

(b) Bruising: (Absent/Slight/Severe)
0 1 2

(c) Wetness: (Normal/Sl.dry or/Mod.dry or/Excess.dryness or
/Sl.drip/Mod.drip /Freezer burn or Excess.drip
0 1 2 3

(d) Autolysis: (Absent/moderate/severe)
(Discolourations) 0 1 2

(e) Parasites: (Absent/moderate/severe)
(Infestations) 0 1 2

(f) Other discolourations or contaminants (bones, membranes, tissues etc.) (Absent/present)
0 1

EASE OF SKINNING: (Easy/Sl.difficult/difficult)
0 1 2

by the author after a literature search and observations made during the preliminary part of the study. It has a maximum accumulated demerit score of 34.

2.40 Organoleptic Acceptability Panel of the cooked fish

Filleted samples of both fish species which had been frozen in a cold room at -18°C and then thawed as above were used for the acceptability taste panels. The fillets were skinned and cut into 30 to 40 g pieces, crumbed and deep fried (Bremner *et al.* 1985). Three or four treatments were cooked simultaneously at each session and the fish served with packets of 'take-away french fries'. Tomato sauce, vinegar and salt were available. Each of the samples were randomised in such a way so as to give a high degree of balance (Table 5 and 6). Letters that represent the samples were also picked randomly. The fish was assessed by 20 panellists employed at the Tasmanian Regional Laboratory and experienced with facial hedonic scaling, for flavour, texture and overall acceptability using the General Foods 'Smiley' scale (Appendix 2). Salt was not mentioned with the Smiley questionaire for blue grenadier, so that the panel should have no preconceived prejudices.

2.50 Statistics

Data from the sensory assessment of the whole gutted and ungutted raw fish (both TFRU and EEC score sheets) and from the sensory assessment of the frozen, filleted raw fish samples of both the blue grenadier stored in RSW and whiting stored in ice were analysed for correlation using the ELF scatter module (Appendix 3 and 4).

The acceptability taste panel assessment scores for flavour, texture and overall liking of the two species of fish were subjected to analysis of variance using the Genstat package. (Appendix 5 and 6).

Table 5

Order of presentation of the cooked blue grenadier samples to the acceptability taste panelists.

Panelist	Order of presentation of samples		
	Session I	Session II	Session III
1	GRUO	SDTM	KLPN
2	GUOR	SMDT	LNKP
3	GORU	DTMS	PLKN
4	GROU	TDMS	NPLK
5	GURO	STMD	KNLP
6	RUOG	MSDT	PNKL
7	ROGU	STDM	NKPL
8	RGUO	DMST	LKPN
9	RUGO	TDSM	LKNP
10	ROUG	MDTS	NLPK
11	UOGR	TMSD	PNLK
12	UGRO	TMDS	LPNK
13	UROG	SMTD	KPNL
14	UORG	DTSM	KPLN
15	UGOR	DSMT	NLKP
16	OGRU	TSMD	KNPL
17	ORUG	DSTM	LPKN
18	OUGR	MSTD	NKLP
19	OGUR	MDST	PLNK
20	ORGU	MTDS	PKNL

Note:

Sample code	N	D	G	L	S	R	K	T	U	P	M	O
Storage time in RSW (days)	3	4	6	8	9	10	11	12	13	14	17	21

Table 6

Order of presentation of cooked whiting samples to the acceptability taste panelists.

Panelist	Order of presentation of samples	
	Session I	Session II
1	OTP	DRL
2	MUS	KRG
3	SPO	DNL
4	TMU	GKR
5	POT	NGK
6	USM	LDN
7	OSP	RLD
8	MUT	NKD
9	USO	RGL
10	SMP	LGN
11	PMT	GKN
12	TUO	KRD

Note:

Sample code	O	M	D	G	T	S	N	R	P	U	L	K
Storage time in ice (days)	1	3	5	7	9	11	13	15	17	19	21	23

3.00 RESULTS

3.10 Physical Characteristic of *M. novaezelandiae*

From the forty-six fish examined, the mean fork length was found to be 76.2 cm (range 60.9 to 83.8 cm). A few of the fish examined had well-developed roes and their digestive tracts were found to be relatively empty.

3.20 Physical Characteristics of the *H. semifasciata*

From a total of thirty-six fish examined, the mean weight of the fish was found to be 66.2 g (range 27 to 186 g) and the mean fork length was 18.3 cm (range 15.6 to 26.5 cm).

3.30 Sensory assessment of the raw blue grenadier samples stored in RSW.

The results of the sensory assessment of the raw blue grenadier samples stored in RSW by the four methods of scoring are given as average total accumulated demerit point scores as shown in Table 7. Figure 1 shows the graph of demerit point versus days in RSW by the four methods of sensory assessment used; Table 9 shows the correlation analysis.

3.40 Sensory assessment of the raw whiting samples stored in ice.

The results of the sensory assessment of the raw whiting samples stored in ice by the four methods of scoring are given as average total accumulated demerit point scores as shown in Table 8. Figure 2 shows the graph of demerit point versus days in ice of the four methods of sensory assessment used; Table 9 shows the correlation analysis.

3.50 Attributes contributing to total score.

Attributes that contribute to total score using the TFRU scores (ungutted and gutted), EEC scores and the filleted sample scores are as shown in Tables 10 - 14.

Table 7

Total demerit points from sensory assessment of blue grenadier samples stored in RSW.

Days in RSW	TFRU scores (ungutted)	TFRU scores (gutted)	EEC scores (gutted)	Filleted Sample Scores
		Average Total Demerit Point Scores		
3	3	3	1	1
4	5	5	2	3
6	10	10	6	6
8	16	18	9	8
9	19	21	11	10
10	20	22	13	12
11	22	24	15	14
12	23	25	18	17
13	24	26	19	18
14	25	27	19	19
17	29	31	21	23
21	33	35	25	29

Note:

Maximum possible scores for
(i) TFRU scores (ungutted is 35
(ii) TFRU scores (gutted) is 29
(iii) EEC scores (gutted) is 30
(iv) Filleted sample scores is 32

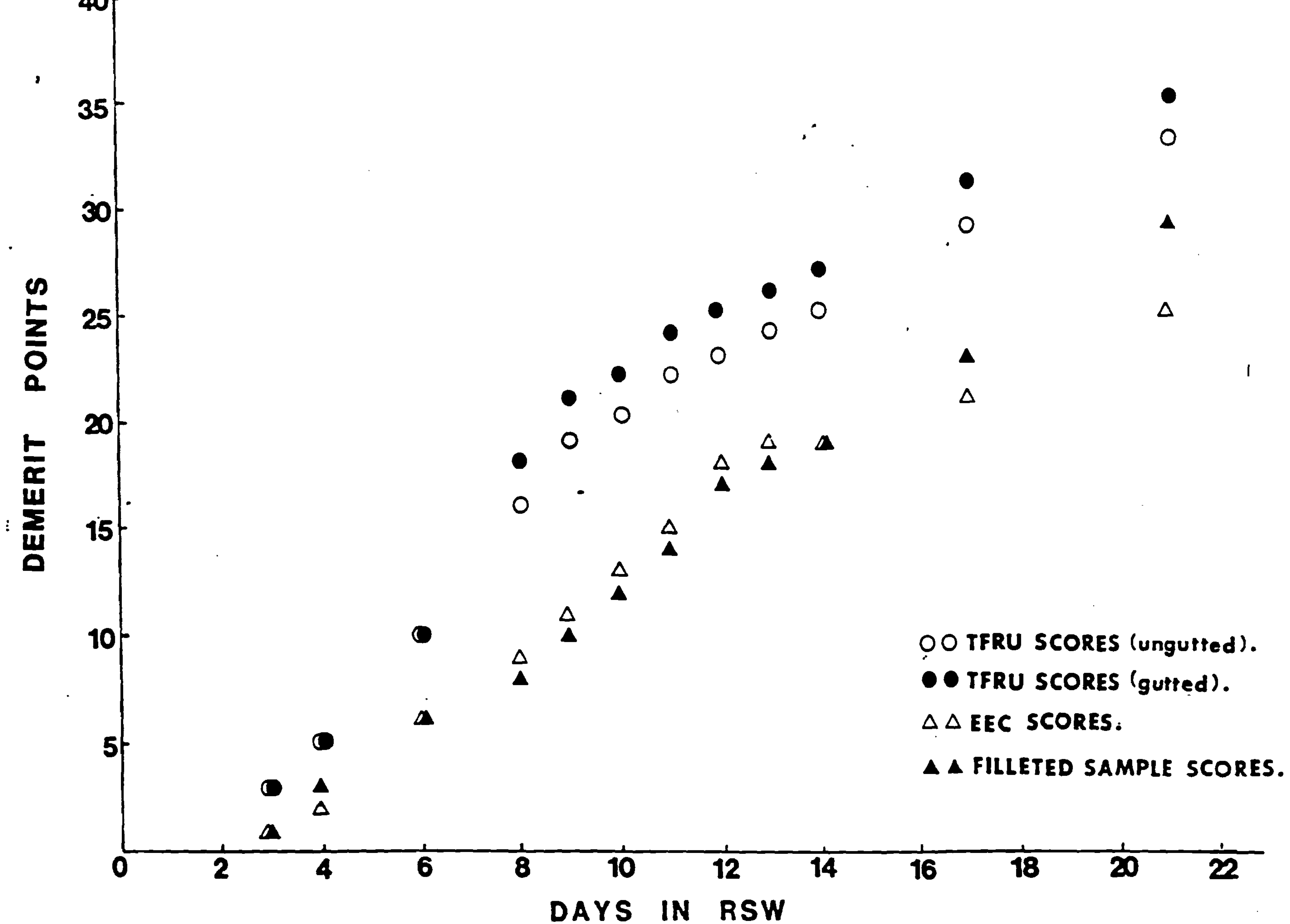


Fig.1 : Demerit Points Versus Days in RSW For Blue Grenadier Samples.

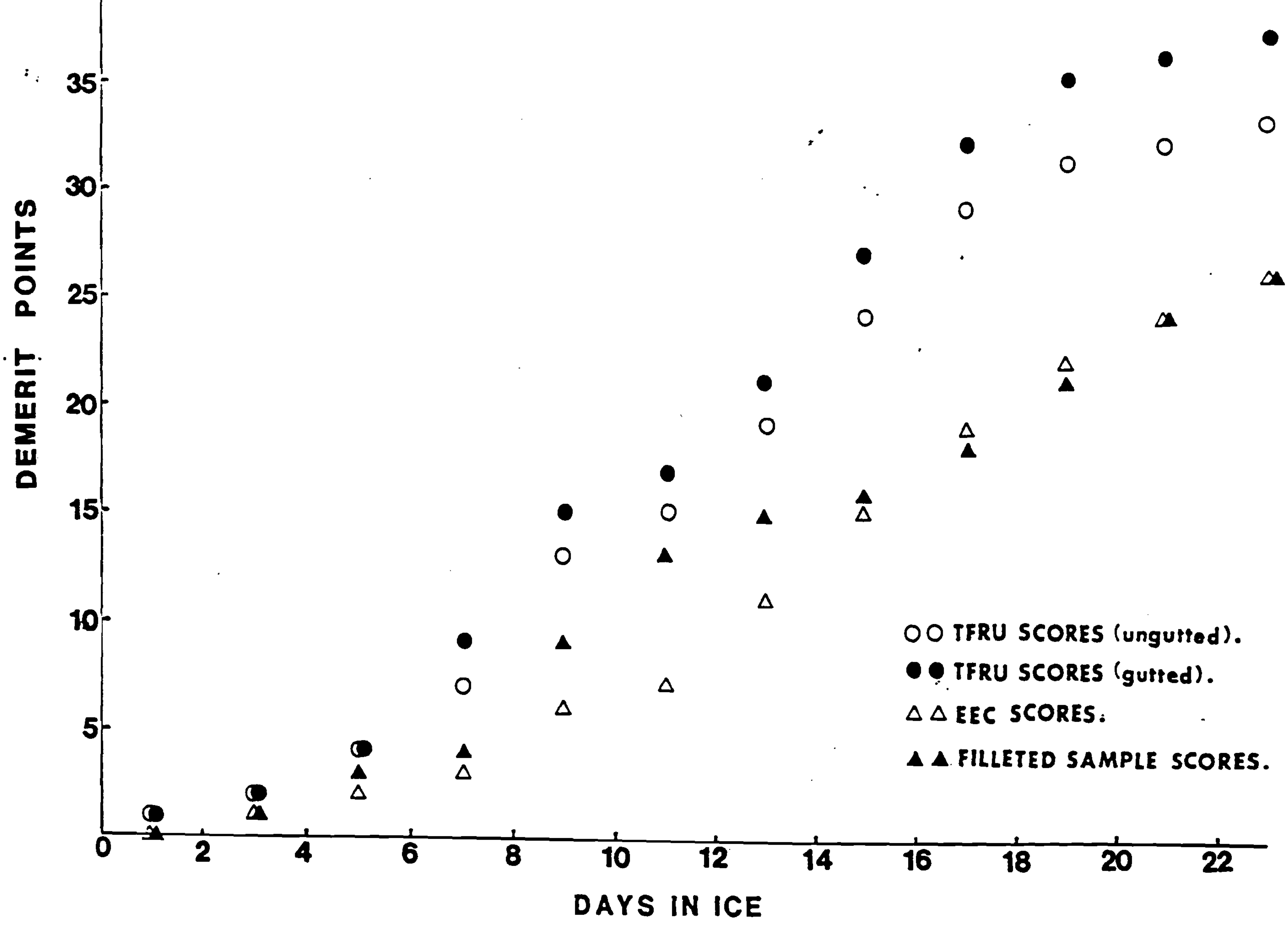


Fig. 2: Demerit Points Versus Days in ice For Whiting Samples.

Table 8

Total demerit points from sensory assessment of whiting samples stored in ice.

Days in ice	Average Total Demerit Point Scores TFRU scores (ungutted)	TFRU scores (gutted)	EEC scores (gutted)	Filleted sample (gutted)
1	1	1	0	0
3	2	2	1	1
5	4	4	2	3
7	7	9	3	4
9	13	15	6	9
11	15	17	7	13
13	19	21	11	15
15	24	27	15	16
17	29	32	19	18
19	31	35	22	21
21	32	36	24	24
23	33	37	26	26

Note:

Maximum possible scores for (i) TFRU scores (ungutted) is 35
(ii) TFRU scores (gutted) is 39
(iii) EEC scores (gutted) is 30
(iv) Filleted sample scores is 32

Table 9

Relationship between time and demerit points
for fish stored in RSW

Method of Visual Assessment	Y-intercept	slope	correlation
M. novaezelandiae			
TFRU (ungutted samples)	0.32	1.75	0.97
TFRU (gutted samples)	0.32	1.90	0.96
EEC	-2.31	1.46	0.97
Filleted samples	-3.57	1.58	0.99
H. semifasciata			
TFRU (ungutted samples)	-2.45	1.67	0.99
TFRU (gutted samples)	-2.73	1.87	0.99
EEC	-4.14	1.29	0.98
Filleted samples	-2.44	1.25	0.99

Table 10

Attributes contributing to total score using TFRU scores (gutted and ungutted)

Score	Attributes involved in score change	
	Blue grenadier in RSW	Whiting in ice
<10	Stiffness; Eyes - clarity, blood; Slime; Gills - smell; Vent - smell.	Stiffness; Eyes - clarity, shape and blood; Slime; Gills - colour, smell and mucous; Vent - smell; Belly cavity - stains and blood.
>10<20	Appearance; Eyes-shape; Stiffness; Gills - smell, colour and mucous; Skin; Scales; belly - discolouration and firmness Vent - smell and condition; Belly cavity - stains and blood.	Stiffness; appearance; gill-smell; Scales; belly-discolouration and firmness; Vent - smell
>20<30	Appearance; Slime; Eyes - clarity, shape, blood and iris; Gills - colour; Belly - discolouration.	Appearance; Slime; Scales; Skin; Eyes - clarity and shape; Gills - mucous, smell and colour; Vent - condition and smell Belly cavity - blood.
>30	Appearance; Gills - mucous and smell; Belly - discolouration and firmness; Vent - condition and smell; Belly cavity - blood.	Slime; Eyes - iris and blood; Belly - discolouration and firmness; Vent - condition Belly cavity - stains.

Table 11

Attributes contributing to total score using EEC scores

Score	Attributes involved in score change	
	Blue grenadier in RSW	Whiting in ice
<7	Appearance - skin, eyes, gills, organs; Physical condition - flesh; Odour-gills, skin and abdominal cavity	Appearance-skin, eyes, gills, flesh and organs; Odour-gills, skin and abdominal cavity.
>7<14	Appearance-skins, eyes, gills, flesh, vertebral column and organs; Physical condition - flesh.	Appearance-eyes and organs; Physical condition-flesh and peritoneum; Odour-gills, skin and abdominal cavity.
>14<21	Appearance-eyes, flesh and vertebral column; Physical condition-vertebal column and peritoneum; Odour-gills, skin and abdominal cavity.	Appearance-skin, gills and organs; Physical condition-flesh, vertebral column and peritoneum. Odour-gills, skin and abdominal cavity.
>21	Appearance-skin, eyes, gills, flesh and vertebral column; Physical condition-flesh and peritoneum; Odour-gills, skin and abdominal cavity.	Appearance-skin, eyes, gills, flesh and vertebral column Physical condition-flesh, vertebral column and peritoneum.

Table 12

Attributes contributing to total score using filleted sample scores

Score	Attributes involved in score change	
	Blue grenadier in RSW	Whiting in ice
<5	Appearance - blood stains, skin colour; Odour - flesh.	Appearance - skin colour, Odour - flesh. Condition - gaping, wetness.
>5<10	Appearance - colour of flesh; Texture - flesh; Condition - gaping, bruising, wetness.	Appearance - colour of flesh, blood stains, skin colour; Ease of filleting; Texture - flesh.
>10<20	Appearance - colour of flesh, blood stains, clotting, skin colour; Odour - flesh; Condition - gaping, wetness, autolysis, other discolourations; Ease of skinning.	Appearance - colour of flesh, clotting, skin skin colour; Odour - flesh Condition - gaping, bruising, wetness, autolysis and other discolouration.
>20	Appearance - colour of flesh, blood stains; skin colour; Texture - flesh; Odour - flesh; Condition - gaping, bruising, wetness, autolysis. Ease of skinning.	Appearance - colour of flesh, blood stains, clotting; Texture - flesh; Odour - flesh; Condition - wetness, autolysis.

Table 13

Different emphasis in scoring systems for whole fish as between the EEC and TFRU.

Attribute	Number of potential demerit points TFRU	EEC
Appearance (general)	3	0
skin, scales, slime	6	3
Stiffness (Rigor)	2	0
Eyes	7	3
Gills	7	6
Belly	5	0
Vent	5	0
Belly cavity	4	3
Flesh cut from abdomen	0	3
Flesh texture	0	3
Vertebral column	0	6
Internal organs	0	3

3.60 Relative merits of the scoring systems

The four scoring methods were used on the same samples of fish. Any sample had therefore deteriorated to the same extent on any one day. Figs 3 and 4 show the scores converted to percentages of possible demerit point scores. The discrepancy in the accumulation of demerit points between the EEC and TFRU scoring methods is clearly shown. Reference to Table 2, 3 and 13 show that this is caused by the lack of questions regarding rigor, looseness of scales, condition of belly and vent and the grouping of colour and mucous in the gills as single points, thus halving the potential gill demerit point score. Comparison of the two species in Table 9 shows that the rate of accumulation of demerit points was more consistent for the TFRU system than by the EEC scoring method or by scoring of fillets.

3.70 Time taken to score the fish

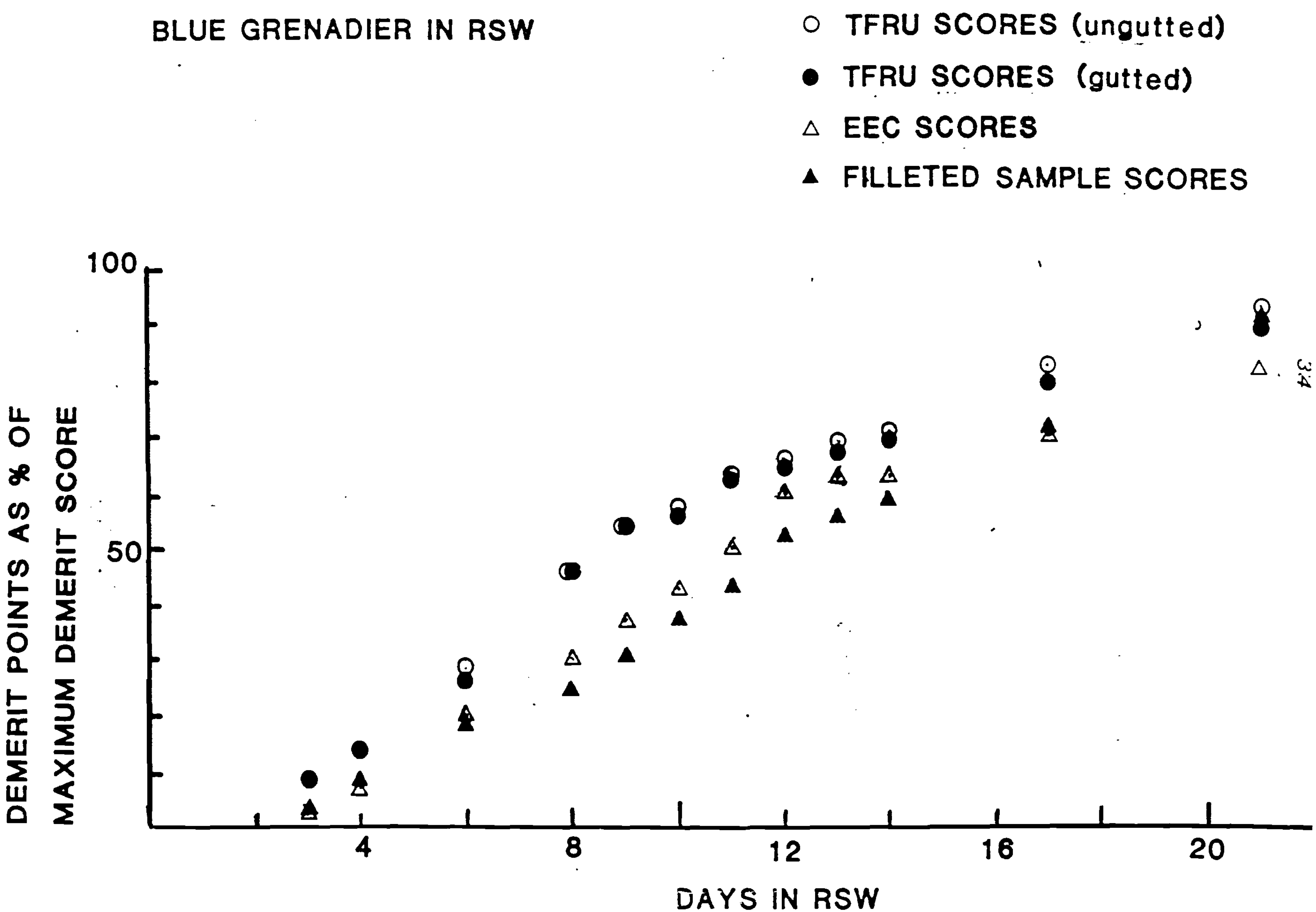
The average time taken to score an individual fish using the TFRU (ungutted) scores, TFRU (gutted) scores, EEC scores and the filleted sample scores were found to be 1 min 25 sec, 1 min 55 sec, 3 min 45 sec and 1 min 50 sec respectively. The EEC score sheet is more time consuming in that more than one question is asked about an attribute for the giving of only one demerit point, this requires conscious thought.

3.80 Acceptability taste panel results of blue grenadier samples.

Figures 5, 6 and 7 show the mean taste panel scores in graphic form for flavour, texture and overall acceptability of cooked blue grenadier samples stored in RSW; table 14 shows the results of the statistical analysis.

3.90 Acceptability taste panel results of whiting samples.

Figures 8, 9 and 10 show the mean taste panel scores in graphic form for flavour, texture and overall acceptability of cooked whiting samples stored in ice; table 15 shows the results of the statistical analysis.



BLUE GRENADIER IN RSW
○ TFRU SCORES (ungutted)
● TFRU SCORES (gutted)
△ EEC SCORES
▲ FILLETED SAMPLE SCORES
DEMERIT POINTS AS % OF MAXIMUM DEMERIT SCORE
100
50
4
8
12
16
20
DAYS IN RSW

FIG.3

34

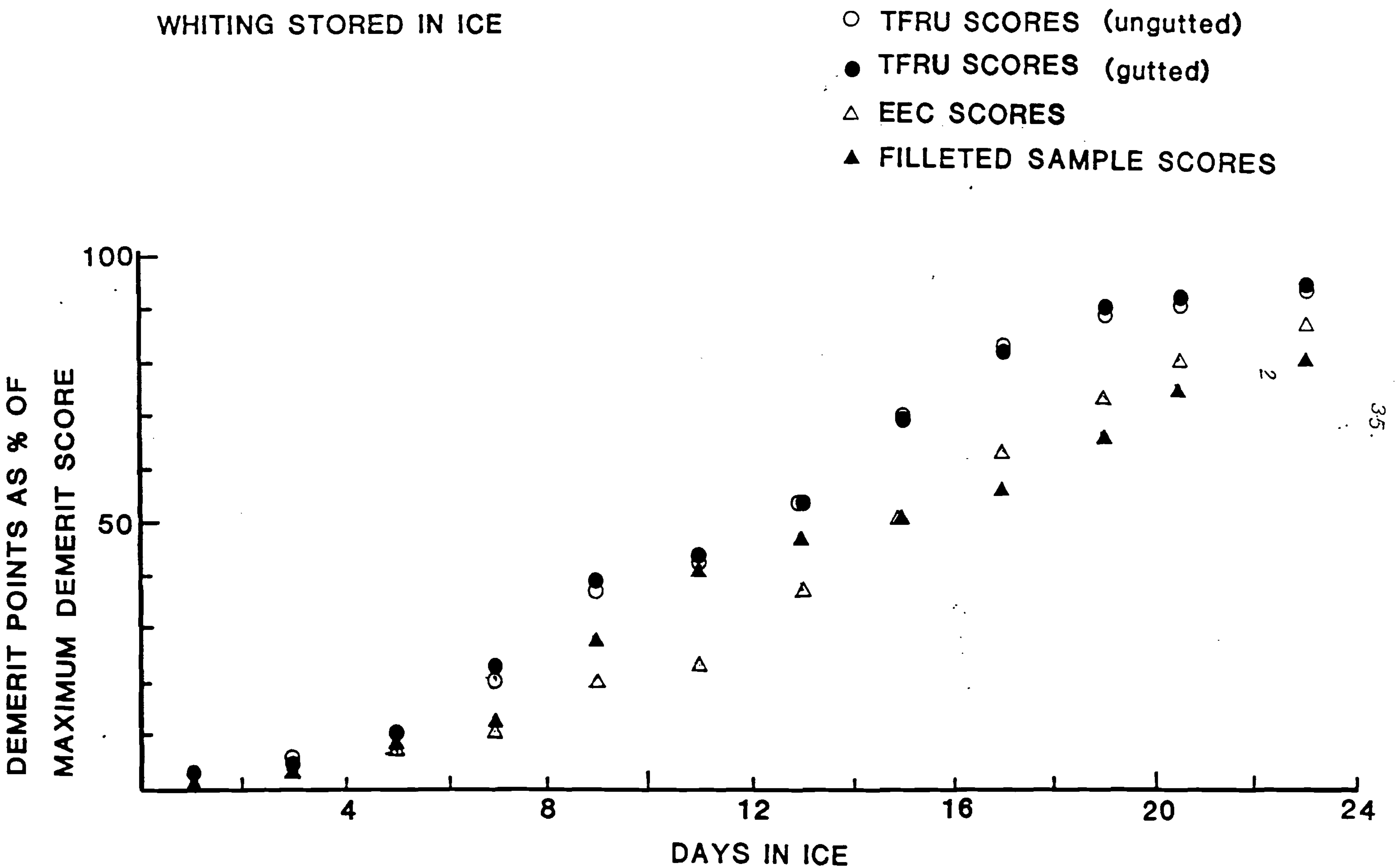

WHITING STORED IN ICE
TFRU SCORES (ungutted)
TFRU SCORES (gutted)
EEC SCORES
FILLETED SAMPLE SCORES
DEMERIT POINTS AS % OF MAXIMUM DEMERIT SCORE
100
50
4
8
12
16
20
24
DAYS IN ICE

FIG.4

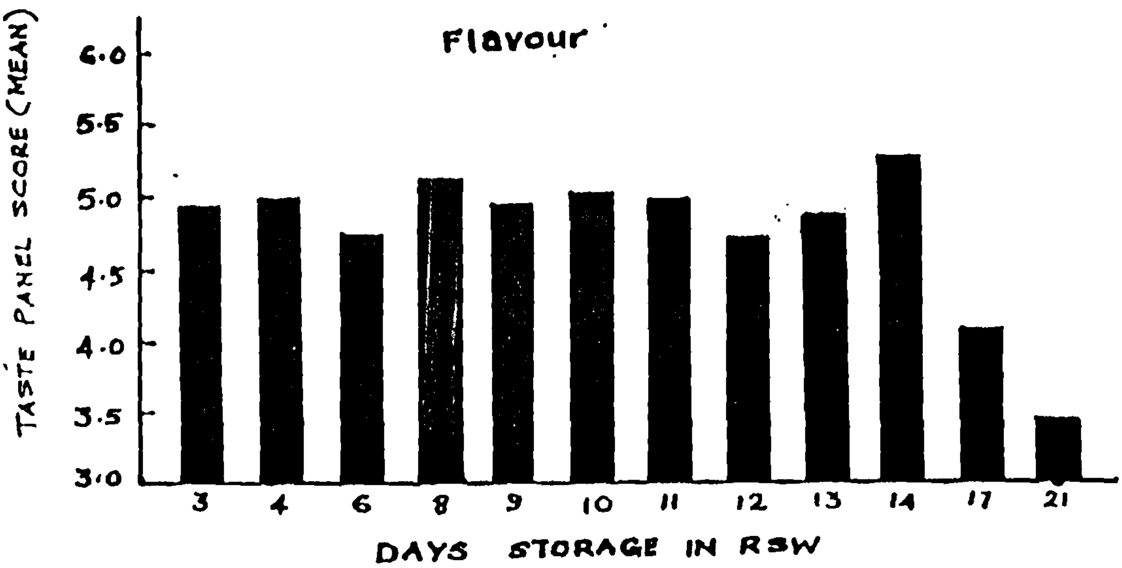


FIG. 5 : Taste panel results of blue grenadier - flavour acceptability

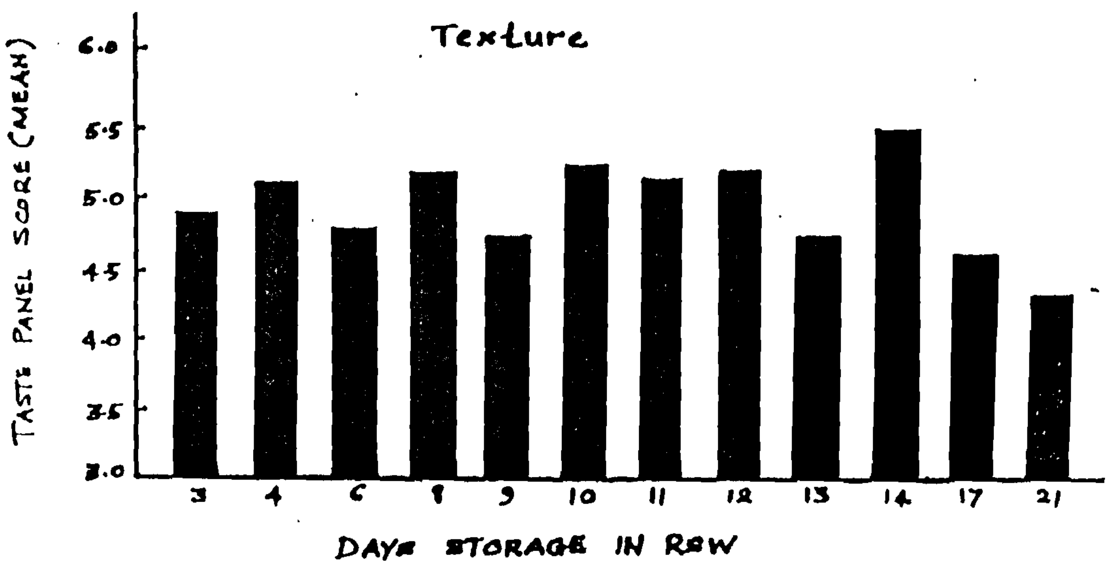


FIG. 6 : Taste panel results of blue grenadier - texture acceptability

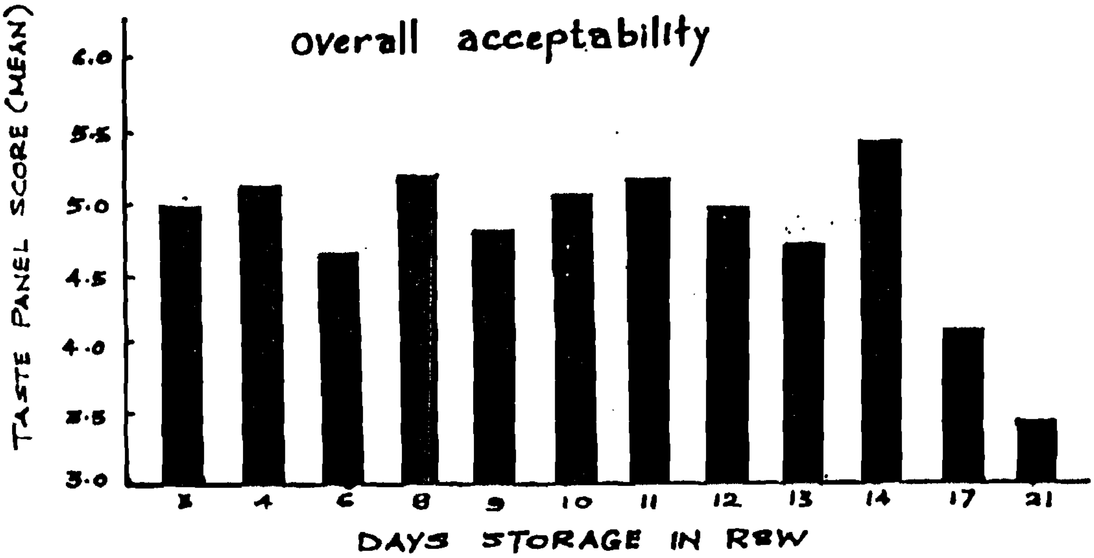


Fig. 7 : Taste panel results of blue grenadier - overall acceptability

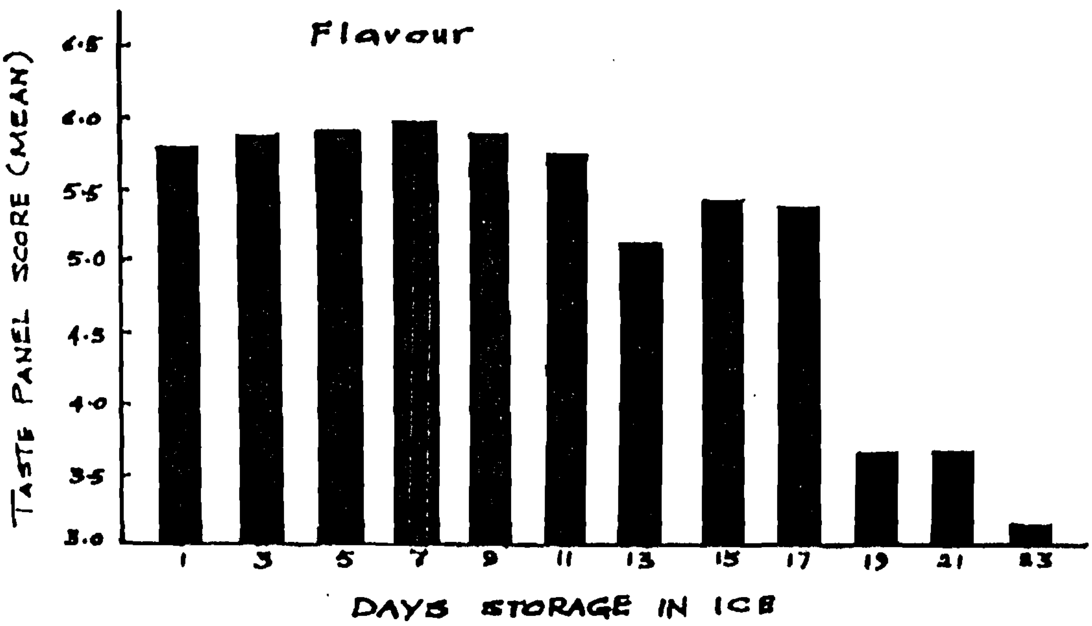


FIG. 8 : Taste panel results of whiting - flavour acceptability

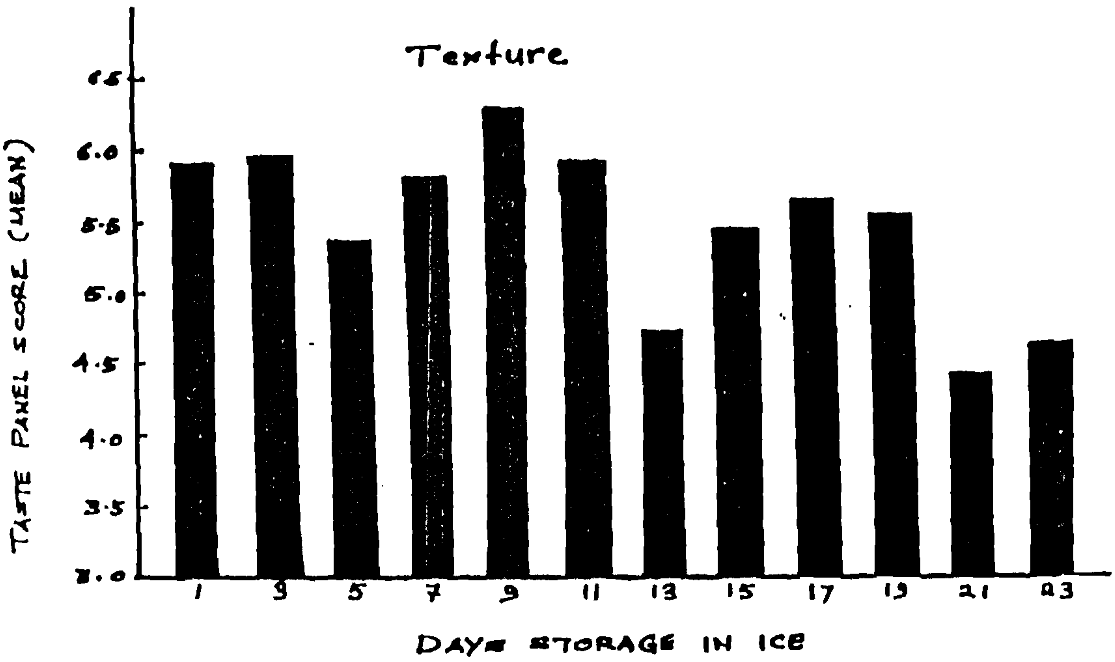


FIG.9 : Taste panel results of whiting - texture acceptability

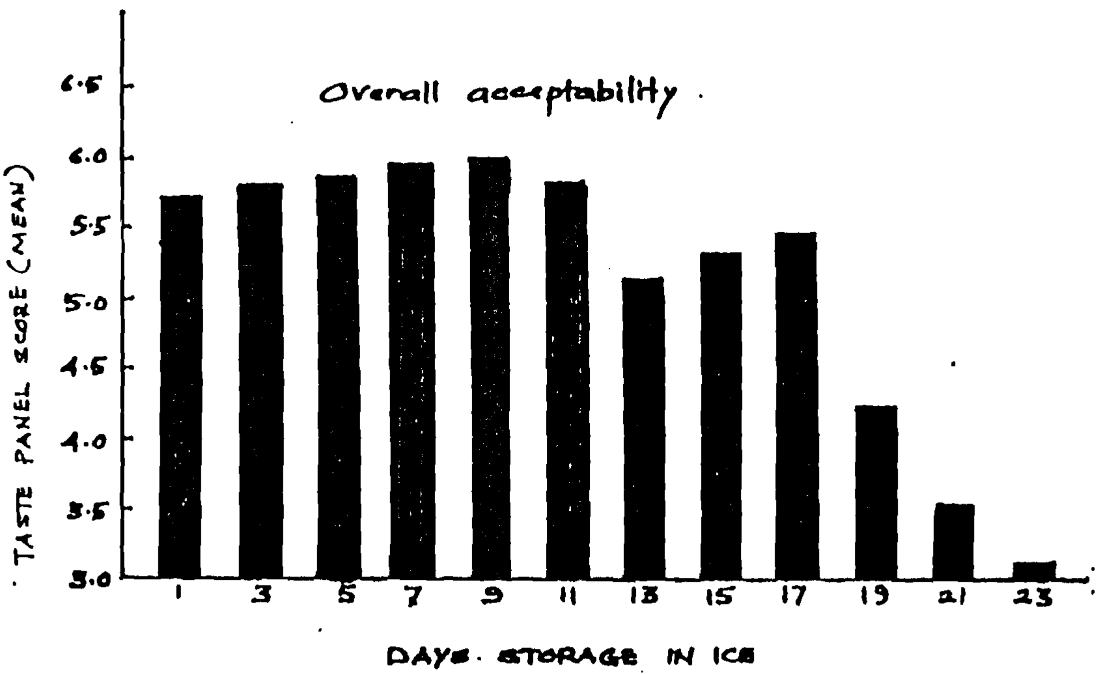


FIG.10 : Taste panel results of whiting - overall acceptability

Table 14

Acceptability of deep fried blue grenadier samples stored in RSW.

Acceptability	Days in RSW											
	3	4	6	8	9	10	11	12	13	14	17	21
Flavour	5.0^{a}	5.0^{a}	4.8^{a}	5.1^{a}	5.0^{a}	5.1^{a}	5.0^{a}	4.8^{a}	4.9^{a}	5.3^{a}	4.1^{b}	3.5^{b}
Texture	4.9^{bc}	5.1^{abc}	4.8^{bcd}	5.2^{ab}	4.8^{bcd}	5.3^{ab}	5.2^{abc}	5.2^{ab}	4.8^{bcd}	5.5^{a}	4.6^{cd}	4.3^{d}
Overall	5.0^{ab}	5.1^{ab}	4.7^{bc}	5.2^{ab}	4.8^{b}	5.1^{ab}	5.2^{ab}	5.0^{ab}	4.7^{b}	5.4^{a}	4.1^{c}	3.5^{d}

a,b,c significantly different ($p<0.001$)

d significantly different ($p<0.01$)

Table 15

Acceptability of deep fried whiting samples stored in ice

Acceptability	Days in ice											
	1	3	5	7	9	11	13	15	17	19	21	23
Flavour	5.8^{ab}	5.9^{a}	5.9^{a}	6.0^{a}	5.9^{a}	5.8^{ab}	5.1^{b}	5.4^{ab}	5.3^{ab}	3.7^{c}	3.7^{c}	3.1^{c}
Texture	5.9^{ab}	5.9^{a}	5.3^{bcd}	5.8^{ab}	6.3^{a}	5.9^{ab}	4.7^{cde}	5.4^{bc}	5.6^{ab}	5.5^{ab}	4.4^{e}	4.6^{de}
Overall	5.7^{ab}	5.8^{ab}	5.9^{ab}	6.0^{a}	6.0^{a}	5.8^{ab}	5.2^{b}	5.3^{ab}	5.5^{ab}	4.2^{c}	3.6^{cd}	3.1^{d}

a,b,c,d,e significantly different ($P<0.001$).

4.00 DISCUSSION

4.10 Sensory assessment of the raw blue grenadier samples stored in RSW.

The results of sensory assessment on the raw blue grenadier samples stored in RSW by the four methods of scoring all show that there is progressive increment in total demerit points with storage time for all the four methods (Table 7). It was also found that the accumulation of demerit points with time of storage of the fish in RSW occurred in a semi-linear fashion for all the four scoring methods used (Figure 1). The variables (time of storage and demerit points score) were all highly correlated (Table 9). The correlation equation of the TFRU (ungutted samples) and TFRU (gutted samples) scores were similar, both having a zero time intercept of 0.32 but with the TFRU (gutted samples) scores having a slightly greater slope by 0.15.

The EEC scores and the filleted sample scores both have lower slopes i.e. 1.46 and 1.58 respectively compared with the TFRU (ungutted sample) and TFRU (gutted sample) scores of 1.75 and 1.90 respectively. However, the EEC scores which have the lowest slope; have a fairly similar correlation equation with the filleted sample scores (Table 9). The negative intercepts reflected the slightly more sigmoid relationship for these samples. This suggests that the TFRU (gutted) scoring method is the most sensitive of the four methods, followed by the TFRU (ungutted), the filleted sample and the EEC scores.

It was also found that after 21 days of storage in RSW, the blue grenadier samples had not reached their maximum possible scores in any of the four scoring methods used (Table 7). The TFRU (ungutted sample) score only reached 94.3% of its possible maximum value whereas the TFRU (gutted sample) scores, EEC scores and the filleted sample score reached only 89.7%, 83.3% and 90.6% of their possible maximum score. This means that all the four methods of scoring can still be sensitive to changes in the quality of the blue grenadier samples stored in RSW after 21 days of storage time.

Figures 1 and 3 also show that the pattern of the graphs of demerit points against days storage in RSW of the four methods of scoring is similar i.e. a tendency to be slightly sigmoid. However, the filleted sample scores seem to be more sensitive than the EEC scores at the later part of the storage time i.e. after 14 days of storage, and the scores continued to rise.

The most obvious indicator of change for the blue grenadier stored in RSW using the TFRU scores (both gutted and ungutted samples) was the eyes (clarity and blood), followed by odour development of the gills (Table 10). This is also found to be true with the EEC freshness score (Table 11). For the filleted sample scores, the appearance and odour of the flesh seems to be the most obvious indicator of change followed by the condition of the fillets such as gaping, bruising and wetness (Table 12).

4.20 Sensory assessment of the raw whiting samples stored in ice.

The results of sensory assessment on the raw whiting samples stored in ice by the four methods of scoring also shows that there is a progressive increment in total demerit points with storage time for all the four methods of scoring (Table 8). As with the blue grenadier, the accumulation of demerit points with time of storage of the whiting in ice also occurred in a semi-linear fashion for all the four scoring methods used (Figure 2 and 4) with a slight lag in the initial phase. Interestingly, this was not observed in the case of blue grenadier samples stored in RSW probably because the first sampling of the blue grenadier starts only from the third day after catch whereas the first sampling of the whiting starts from the first day after catch. Also the blue grenadier was handled quite roughly on the deck, in fact three out of the four fish samples on the first removal i.e. the third day after catching, had already showed blood in their eyes.

Bremner et al (1985) when using the TFRU score sheet to assess the quality of four tropical fish species from the north west shelf of Australia (stored in ice) also found that the accumulation of demerit points with time of storage in ice occurred in a linear fashion.

As with blue grenadier, the variables (time of storage and demerit points score) were all highly correlated (Table 9). Also the correlation equation of the TFRU (ungutted) and TFRU (gutted) scores were similar, with the TFRU (gutted) score having a slightly greater slope by 0.20 (Table 9). The EEC scores and filleted sample scores also have lower slopes i.e. 1.29 and 1.25 respectively compared to the TFRU (ungutted) and (gutted) scores of 1.67 and 1.87 respectively. However, unlike the blue grenadier, the filleted samples of the whiting had the lowest slope. The more sensitive nature of the EEC scores as compared to the filleted sample scores in the case of the whiting especially after 12 days storage in ice can be explained by the smaller size of the whiting (fork length ranging from 15.6 to 26.5 cm) as compared to the size of the blue grenadier (fork length ranging 80.9 to 83.8 cm); the smaller fish tend to spoil faster especially the interior parts of the fish. As the EEC scores depend much on the sensory assessment of the interior parts of the fish such as the appearance and condition of the flesh, vertebral column, interior organs, peritoneum and abdominal cavity (Table 3) which makes up more than 18 demerit points out of the total possible maximum of 30, the sensitiveness of its score is thus self-explanatory in the case of whiting. Connell (1980) explained that large fish keep marginally better than small fish because larger fish have a smaller surface to volume ratio so that in the same time less of their interior is affected.

The above results confirmed the previous suggestion that the TFRU (gutted) scoring method is the most sensitive of the four methods. It was found that after 23 days of storage in ice, the whiting samples had not reached the maximum possible scores in any of the four methods used (Table

8). The TFRU (ungutted) scores had reached only 94-3% of its possible maximum value whereas the TFRU (gutted) scores, EEC scores, and the filleted sample scores reached only 94.9%, 86.7% and 81.3% of their possible maximum score. Therefore, all the four methods of scoring can still be sensitive to changes in quality of the whiting samples stored in ice after 23 days of storage time.

The most obvious indicator of change for the whiting stored in ice using the TFRU score sheet was the eyes (clarity, shape and blood) followed by the development of colour, odour and mucous of the gills (Table 10). Bremner et al (1985) when working with four tropical species from the north west shelf of Australia also found that the most obvious indicator of change for fish stored in ice was the eyes (their clarity and shape) followed by odour development and colour changes in the gills. This was also found in the case of blue grenadier in RSW discussed earlier. Curran et al (1981) when investigating the quality changes during iced storage of three commercially important species of fish from Bahrein also found that, of the visual and olfactory assessments, gill odour showed the most promise as a quality control index. Again this is also found to be true with the EEC freshness score of both the blue grenadier and the whiting (Table 11). According to Howgate (1972), it was generally agreed that odour of the gills is the most sensitive measure of freshness but the visual appearance of the eyes, gills and skin was quicker to use in practice on the market.

For the filleted sample scores of the whiting, the most obvious indicator of change was the appearance and odour of the flesh (Table 12). This too agreed with the findings for blue grenadier stored in RSW.

According to Baines et al (1969), with fish, eating is related to four main attributes or quality factors viz. appearance, odour and texture of the raw and cooked fish and in the latter also flavour. The ultimate purpose of testing the raw fish is to estimate the eating quality, which is here taken to mean the degree of freshness of flavour. According to Baines and Shewan (1965), the most reliable test for predicting flavour score is raw odour.

4.30 The ease and difficulties of using the four methods of scoring.

It was found that the TFRU (ungutted) scores was the easiest and quickest method to use as it takes on average only about 1 min 25 sec to score a fish compared to 1 min 55 sec; 3 min 45 sec, and 1 min 50 sec for the TFRU (gutted), EEC and the filleted sample scores. The EEC score was found to be the most tedious besides taking the longest time to score a fish.

The TFRU (ungutted) scores also have the advantage of not requiring a knife in order to score and also were less messy to work with compared to all the other methods. Also the attributes to be assessed were arranged and organised in such a way in the score sheet that it is easy to score a fish starting from assessing the appearance and skin and ending with the condition and smell of the vent.

4.40 Acceptability taste panel results of the blue grenadier samples.

4.41 Flavour acceptability.

Figure 5 shows the flavour acceptability of the deep fried samples of blue grenadier. Samples stored in RSW for less than 17 days were found statistically (Table /4) to be indistinguishable ($P<0.001$), from each other; then there was a significant fall in the flavour acceptability of the samples stored in RSW for 17 days onwards. The sample stored for 21 days had a still lower mean value of 3.5, but it was not significantly different from the sample stored for 17 days which had a mean value of 4.1 It is interesting to note that despite the progressive increase in sodium uptake of the blue grenadier samples stored in RSW from about 71.15 ± 3.5 mg sodium/100 g tissue initially to 724 ± 33 mg/100 g tissue on the 16th day and to 729 ± 17 mg/100 g tissue on the 21st day (Burford, 1984); the panelists seem not to be negatively affected by the increasing salt content of the samples with storage time; and in fact some of the panelists added more salt to their samples!

This result contradicts statements made by previous reseachers that the storage life using RSW may be limited by increases in salt content in the fish flesh (Boyd et al, 1978). The maximum desirable salt content according to Tomlinson et al (1974) as quoted by Boyd et al (1978) is about 0.5%, but at the 16th day of RSW storage, the salt content found in the flesh of blue grenadier samples was already more than 0.7%. However, the panelist only ate 40g pieces, it might have been a different case if the fish has been as a whole meal.

4.42 Texture acceptability.

Figure 6 shows the texture acceptability of the deep fried blue grenadier samples stored in RSW. Despite some apparent abberant values (such as the high mean of 5.5 for the sample stored for 14 days in RSW), it is obvious that the texture acceptability showed a significant decreasing trend ($p<0.01$) from seventeen days of storage onwards. The abberant texture values are possibly due to the fact that the fish texture might have been masked by the bread crumbs used to coat the fish samples before deep frying. This agrees with the observations of Bremner et al (1985) who found that the inherent textural softness of *P. pictus* and the toughening on storage of *N. peronii* detected by a profile panel using steamed fillets were no longer noticeable when the fish was deep fried in batter. Bremner (1980) also reported that despite the softness of the raw flesh, the cooked flesh of blue grenadier is reasonably firm.

4.33 Overall acceptability.

The overall acceptability of the deep fried blue grenadier samples stored in RSW (figure 7) seems to follow a similar pattern to its flavour acceptability (figure 5); in which a significant fall in overall acceptability was only observed from the samples held from 17 days in RSW onwards ($p<0.001$), as shown in Table 14.

Thus all the above results showed that there was a significant fall in flavour, texture and overall acceptability of blue grenadier from 17 days of RSW storage onwards which was found to be equivalent to the accumulated demerit point scores of 29 of the TFRU (ungutted) scores; 31 of the TFRU (gutted) scores; 21 of the EEC scores and 23 of the filleted sample scores. Jones (1964) states that the acceptability of a fish is a function of its suitability for further processing and of its immediate appearance, its texture, its odour and its flavour.

4.50 Acceptability taste panel results of the whiting samples.

4.51 Flavour acceptability.

Figure 8 shows the flavour acceptability of the deep fried whiting samples stored in ice. The twelve sample times could be analysed individually since the means if analysed by combining adjacent sample times to give six sample groups are in fact the means of the adjacent times if analysed individually, it was found that samples of the first nine removals i.e. up to 17 days of storage in ice are more or less indistinguishable (abberant value at 7th removal). The last three removals i.e. samples stored in ice for 19, 21 and 23 days were found to be of significantly lower flavour acceptability ($p < 0.001$) as shown in Table 5.

4.52 Texture acceptability.

Except for the abberation at the 7th removal i.e. at day 13 of ice storage; there is a significant reduction of texture acceptability at the 21 and 23 days of ice storage ($p < 0.001$) as shown by figure 9 and Table 5.

4.53 Overall acceptability.

The overall acceptability of the whiting samples stored in ice is very much similar to its flavour acceptability except at day 19 of ice storage where the overall acceptability shows a higher mean of 4.2 compared to the flavour acceptability mean of 3.7 (figure 10 and Table 5). There is however a significant sudden drop to low scores from the 10th removal i.e. day 19 of storage in ice ($p < 0.001$).

Thus all the above results for whiting samples showed that there was a significant fall in flavour and overall acceptability from 19 days ice storage onwards which is equivalent to the accumulated demerit points of 31 of the TFRU (ungutted) scores; 35 of the TFRU (gutted) scores; 22 of the EEC scores and 21 of the filleted sample scores. The results are interesting in that the corresponding total accumulated demerit points at the time when significant falls in flavour, texture and overall acceptability of the blue grenadier and whiting samples stored in RSW and ice respectively, were quite similar.

5.00 CONCLUSION

5.10 Feasibility of using demerit points

Accumulation of demerit points with time of storage of *M. novaeselandiae* in RSW and *H. semifasciata* in ice was found to be highly correlated and occurred in a semi-linear fashion irrespective of the method of scoring used.

The slopes of the lines (rate of accumulation of demerit points) and its relative spoilage rate were found to be similar for the two species provided the same method of scoring is employed. This tends to suggest that the method is possibly independent of species and methods of storage or at least applicable to the two species in RSW and ice respectively.

The TFRU (ungutted) scores were found to be the easiest and quickest method to use although the TFRU (gutted) scores were the most sensitive. The EEC freshness scores were however found to be the most tedious and difficult to use besides taking more than twice the time taken to score a fish compared to the TFRU (ungutted) scores.

Although there were slight differences between the two species in those characteristics where changes were first made (Table 10, 11 and 12); there is enough evidence to conclude that the changes in the appearance of the eyes and the odour development of the gills are the most obvious and valuable indicator of change in quality when using the TFRU or the EEC scores while the appearance and odour of the fish flesh seems to be the most obvious indicator when assessing the filleted sample.

The shelf-life of *M. novaezelandiae* stored in RSW was found to be 14 days (less than 17 days) whilst that of *H. semifasciata* stored in ice was found to be 17 days (less than 19 days), beyond which the fish had developed spoilage characteristics that were disliked by the acceptability taste panel.

The cut-off point at which spoilage of the samples would have rendered the quality of the fish sample to be unacceptable from the consumer's point of view would be that equivalent to the accumulated demerit point of >29 for the TFRU (gutted and ungutted) scores and >21 for the EEC and filleted sample scores.

This study thus confirmed the potential use of demerit points such as the TFRU (ungutted) scores as an easy, quick, cheap, non-destructive and reliable method of sensory assessment of fish quality. In fact, Branch and Vail (1985) had studied the possible use of a prototype pocket-sized computer to determine the condition and shelf-life of temperate and tropical species of fish based on data that is derived from the sensory score sheets for the assessment of fish quality developed at the CSIRO Division of Food Research, Tasmanian Food Research Unit (TFRU), Hobart.

5.20 Purpose for which demerit points are to be used

Many scoring systems are used to predict the number of days fish have been stored on ice, and in more recent years "ICETIME" (equivalent days on ice); and thus through years of experience the taste panel acceptability of the fish.

However, fish is sold on appearance and a scoring system may be used for assessing marketability of whole or gutted fish or fillets, or for setting standards in bulk buying. The EEC scoring system is used, for example, at fish markets at first point of sale, to grade the fish and establish withdrawal prices. A Torry/Shewan type system is often used as a purchasing specification from firm to firm.

Before a final demerit point system is selected for any commodity, its ultimate purpose should be established. For example, the demerit points chosen for whole fish which most closely resemble the rate of change of demerit points for fillets of that species might be the most useful.

A linear rate of change of demerit points with time is most favoured because it enables prediction of remaining shelf-life. Consumer unacceptability should be at a point where, perhaps, 75% of the demerit points have been accrued. Further scores would still be available for categories such as "suitable for fish meal". Demerit points are not an indication of the acceptability of fish, as eaten, where off-odours, flavours and fillet discolouration are masked by batters or curries. Their correlation with the odours, flavours, off odours and off flavours of steamed fish are currently being examined by other workers at the Tasmanian Food Research Unit and highly significant correlations are found. Even when fish are subsequently eaten battered or curried demerit points give a good indication of remaining shelf life. Thus whiting with a 'Smiley' flavour score of 5.8 after 1 day on ice has a TFRU gutted demerit score of 1 and a high quality life (eaten crumbed and fried) of a further 16 days, while whiting stored for 11 days on ice with the same flavour score has a gutted demerit score of 17 and a further shelf life of 6 days.

5.30 Suggestion for further work.

To ascertain its potentially wide application as a simple, quick and technically sound method of assessing fish quality, many more studies using other species of fish, both temperate and tropical species, and in various storage conditions should be undertaken using a demerit point scoring system such as that developed by the TFRU.

The score sheet has proved invaluable when sending individuals untrained researchers away on distant water fishing trips. As yet no standard deviations have been determined using a team of assessors with coded samples of unknown history. This may require a separate group design.

The effect of lean fish and fatty fish on the scores should also be studied because factors such as seasonal variations in biological conditions; improper gutting and washing, mechanical damage and filth, and changes due to storage in RSW or shelving may have considerable influence on its shelf-life. Reports such as those of Smith et al (1979) clearly showed that in fish such as the blue whiting (*Micromesistius poutassou*), there is greater degree of seasonal variability than in other gadoid species, the overall acceptability dropping dramatically once the fish have spawned. Fish accepted for processing for food has to be of a higher standard of quality than fish accepted for immediate sale across the counter to the consumer, therefore there is a need to meet a minimum score before they could be processed into food. Grading is therefore best left to the user. Sorenson (1971) states that in establishing limits of acceptance, an allowance had to be made for deterioration that would continue to take place during processing and storage prior to reaching the consumer.

The only final criteria of the objectivity of sensory or any other assessment are results that are reproducible many times which is by definition a long-term process, and in the meantime one requires short-cut indications that one is heading in the right direction.

Perhaps a final caution is necessary, as in the words of Ehrenberg and Shewan (1953), "not too much must be expected; even the best measuring instruments occasionally go out of control".

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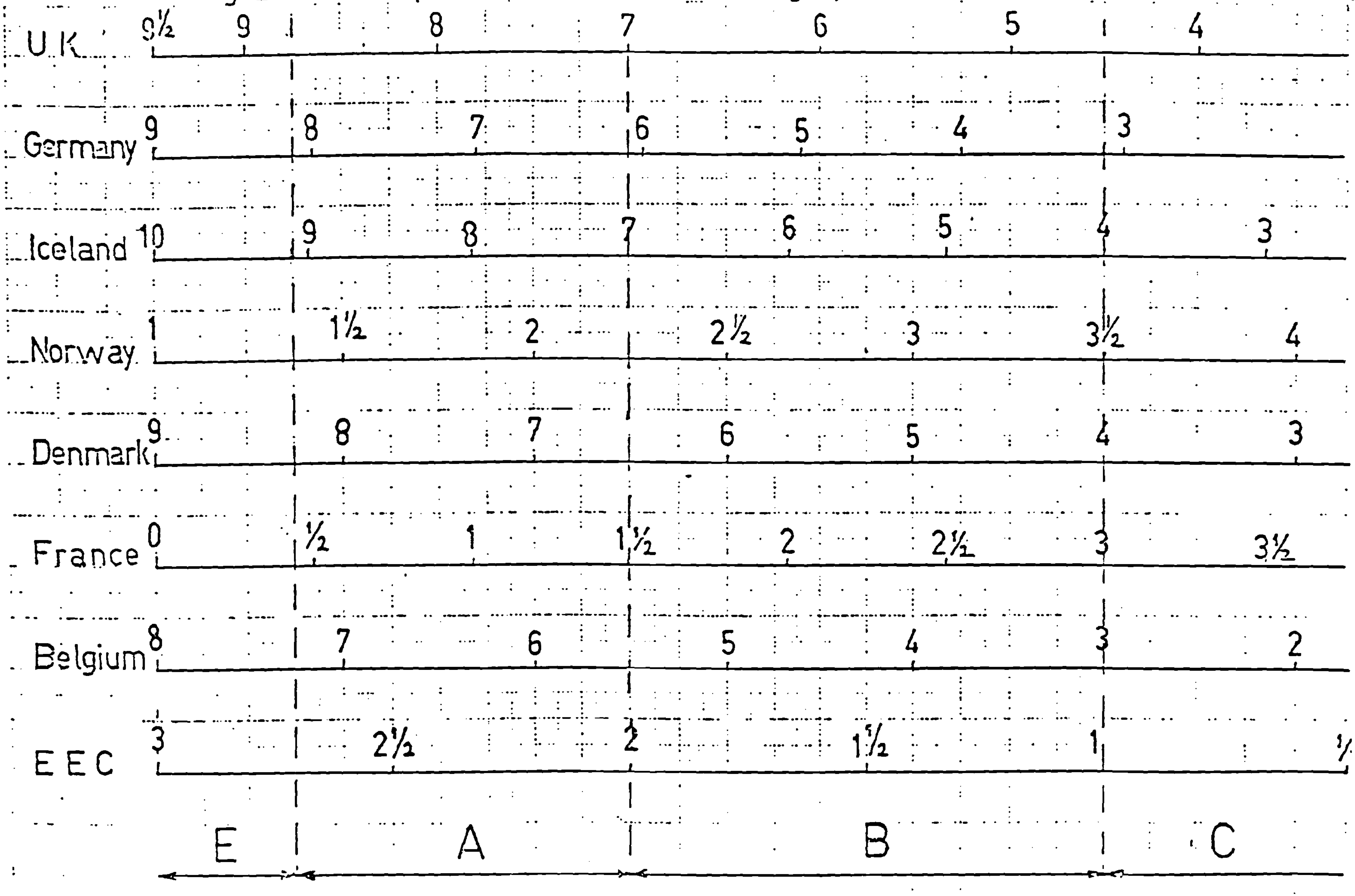
Nomogram for comparison of different scoring systems for raw fish



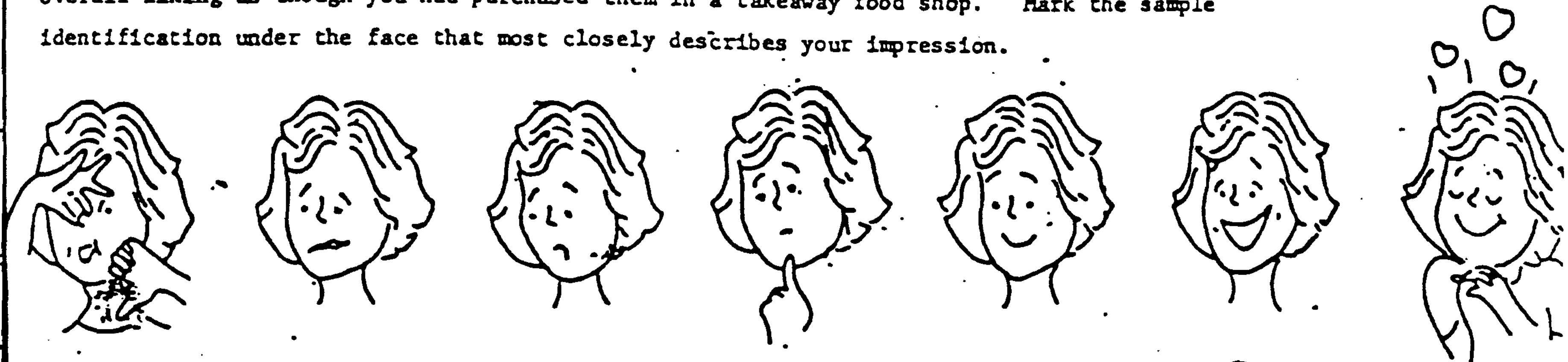
You will be given ..4.. samples of cooked fish. Please assess the fish for flavour, texture and overall liking as though you had purchased them in a takeaway food shop. Mark the sample identification under the face that most closely describes your impression.

TASTER ________

DATE ________

SESSION ________

ORDER ________



	1	2	3	4	5	6	7
FLAVOUR							
TEXTURE							
OVERALL LIKING							

APPENDIX 2

APPENDIX 3

ELF PRINT MODULE
DATABASE: B.GREN.VIS.ASS.(A).

OBS	DAYS-R	DM.PTS
1	3	2
2	3	3
3	3	3
4	3	3
5	4	5
6	4	5
7	4	6
8	4	5
9	6	10
10	6	10
11	6	10
12	6	10
13	8	15
14	8	16
15	8	15
16	8	17
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19	9	19
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22	10	21
23	10	19
24	10	21
25	11	21
26	11	22
27	11	22
28	11	22
29	12	22
30	12	22
31	12	23
32	12	23
33	13	25
34	13	23
35	13	22
36	13	25
37	14	24
38	14	23
39	14	26
40	14	25
41	17	26
42	17	30
43	17	30
44	17	29
45	21	32
46	21	33

ELF SCATTER MODULE
DATABASE: B.GREN.VIS.ASS.(A).

INDEPENDENT VARIABLE (X): DAYS-RSW
DEPENDENT VARIABLE (Y): DM.PTS.

CORRELATION COEFFICIENT .9666
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T STATISTIC 25.01621
INTERCEPT (A) .31789
SLOPE (B) 1.75399
STD ERROR OF ESTIMATE 2.19473

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XMIN -1.9 XMAX 25.9 XINC 2

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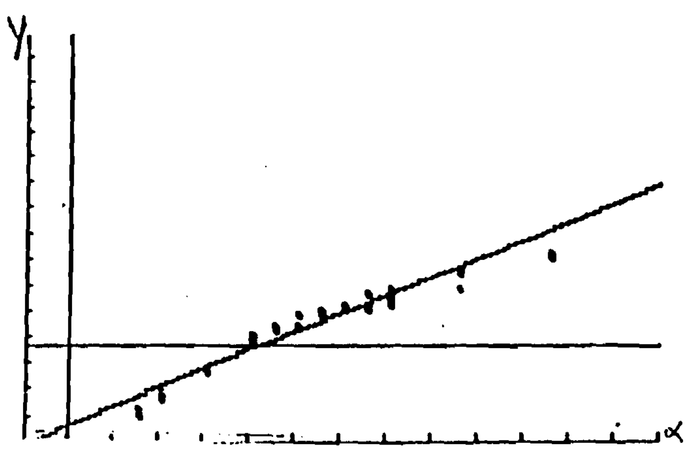

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DATABASE: B.GREN.VIS.ASS.(FIL).

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3	6	6
4	8	8
5	9	10
6	10	12
7	11	14
8	12	17
9	13	18
10	14	19
11	17	23
12	21	29

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ELF SCATTER MODULE
DATABASE: B.GREN.VIS.ASS.(FIL).

INDEPENDENT VARIABLE (X):  DAYS-RSW
DEPENDENT VARIABLE (Y):  DM.PTS.


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R SQUARED .992
T STATISTIC 35.36977
INTERCEPT (A) -3.56541
SLOPE (B) 1.58426
STD ERROR OF ESTIMATE .77667

OBSERVATIONS 12
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YMIN -24     YMAX 55       YINC 5
XMIN -1.9    XMAX 25.9     XINC 2

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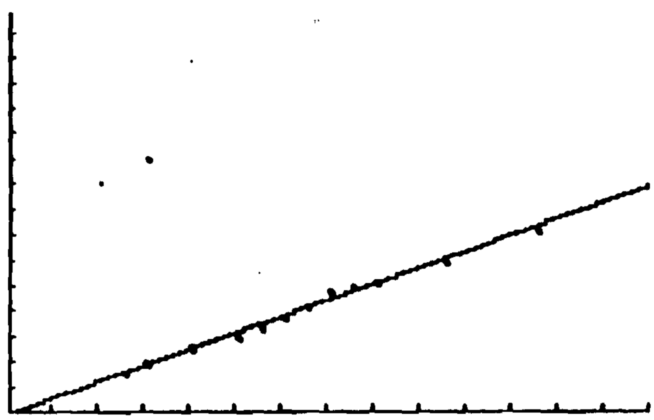

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DATABASE: B.GREN.VIS.ASS.(A/G).

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4	3	3
5	4	5
6	4	6
7	4	5
8	4	5
9	6	10
10	6	10
11	6	10
12	6	10
13	8	17
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37	14	26
38	14	25
39	14	28
40	14	27
41	17	28
42	17	32
43	17	32
44	17	31
45	21	34
46	21	35

ELF SCATTER MODULE
DATABASE: B.GREN.VIS.ASS.(A/G).

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DEPENDENT VARIABLE (Y): DM.PTS.

CORRELATION COEFFICIENT .95765
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T STATISTIC 22.06088
INTERCEPT (A) .32357
SLOPE (B) 1.89812
STD ERROR OF ESTIMATE 2.69324

OBSERVATIONS 46
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XMIN -1.9 XMAX 25.9 XINC 2

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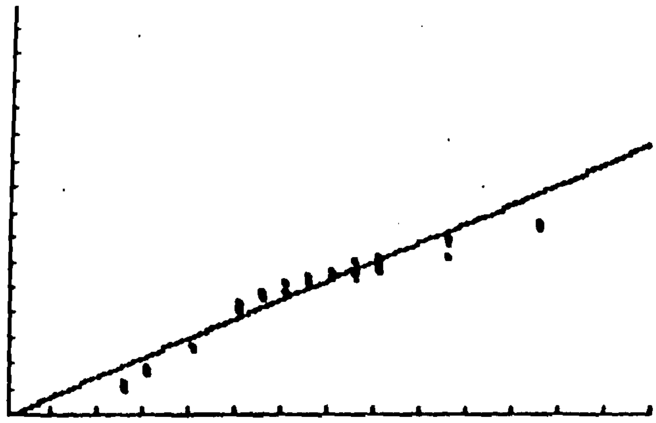

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DATABASE: B.GREN.VIS.ASS.(EEC).

OBS	DAYS-R	DM.PTS
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3	3	1
4	3	1
5	4	1
6	4	4
7	4	3
8	4	1
9	6	6
10	6	6
11	6	6
12	6	6
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38	14	19
39	14	19
40	14	19
41	17	19
42	17	23
43	17	21
44	17	20

45	21	23
46	21	26

ELF SCATTER MODULE
DATABASE: B.GREN.VIS.ASS.(EEC).

INDEPENDENT VARIABLE (X): DAYS-RSW
DEPENDENT VARIABLE (Y): DM.PTS.

CORRELATION COEFFICIENT .96691
R SQUARED .9349
T STATISTIC 25.14Ø24
INTERCEPT (A) -2.3Ø937
SLOPE (B) 1.46219
STD ERROR OF ESTIMATE 1.82Ø58

OBSERVATIONS 46
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XMIN -1.9 XMAX 25.9 XINC 2

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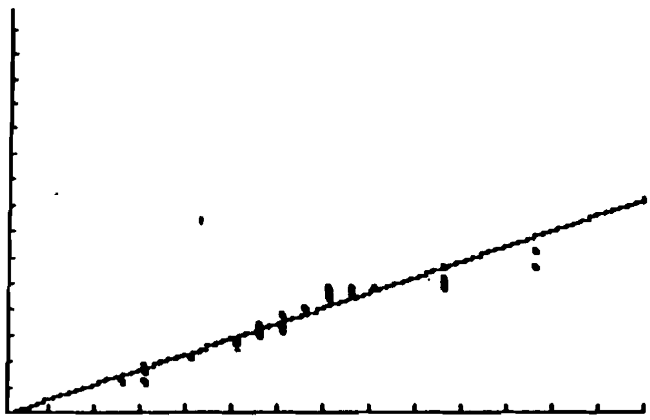

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APPENDIX 4

DATABASE: WHITING VIS.ASS.(A).

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4	3	1
5	3	2
6	3	2
7	5	4
8	5	3
9	5	5
10	7	8
11	7	7
12	7	8
13	9	13
14	9	15
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25	17	29
26	17	29
27	17	30
28	19	30
29	19	30
30	19	32
31	21	33
32	21	32
33	21	32
34	23	32
35	23	32
36	23	34

ELF SCATTER MODULE
DATABASE: WHITING VIS.ASS.(A).

INDEPENDENT VARIABLE (X): DAYS-ICE
DEPENDENT VARIABLE (Y): DM.PTS.

CORRELATION COEFFICIENT .98514
R SQUARED .9705
T STATISTIC 33.44414
INTERCEPT (A) -2.45163
SLOPE (B) 1.66958
STD ERROR OF ESTIMATE 2.06798

OBSERVATIONS 36
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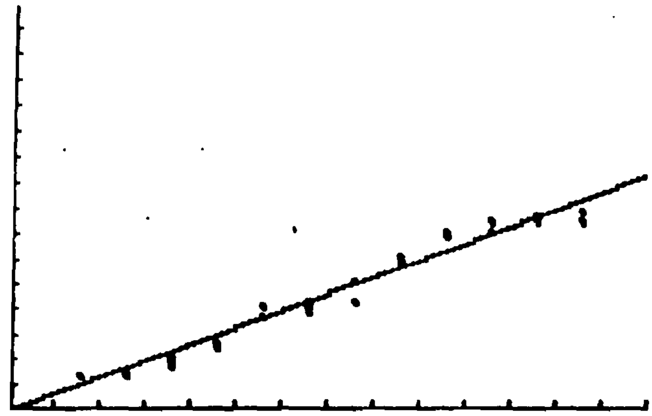

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]PR#6ELF PRINT MODULE
DATABASE: WHITING VIS.ASS.(A/G).

OBS	DAYS-I	DM.PTS
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2	1	1
3	1	1
4	3	1
5	3	2
6	3	2
7	5	4
8	5	3
9	5	5
10	7	10
11	7	9
12	7	10
13	9	15
14	9	17
15	9	15
16	11	18
17	11	16
18	11	17
19	13	22
20	13	18
21	13	22
22	15	26
23	15	27
24	15	28
25	17	32
26	17	32
27	17	33
28	19	34
29	19	34
30	19	36
31	21	37
32	21	36
33	21	36
34	23	36
35	23	36
36	23	38

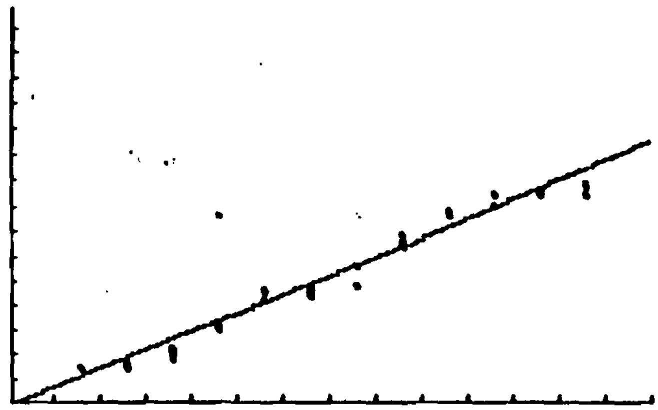
ELF SCATTER MODULE
DATABASE: WHITING VIS.ASS.(A/G).

INDEPENDENT VARIABLE (X): DAYS-ICE
DEPENDENT VARIABLE (Y): DM.PTS.

CORRELATION COEFFICIENT .98642
R SQUARED .973
T STATISTIC 35.01678
INTERCEPT (A) -2.72533
SLOPE (B) 1.87063
STD ERROR OF ESTIMATE 2.21294

OBSERVATIONS 36
Y: DM.PTS.   X: DAYS-ICE
YMIN -19.5   YMAX 59.5   YINC 5
XMIN -1.9   XMAX 25.9   XINC 2

]



?SYNTAX ERROR
]PR#6ELF PRINT MODULE

DATABASE: WHITING VIS.ASS.(EEC).

OBS	DAYS-I	DM.PTS
1	1	0
2	1	0
3	1	0
4	3	0
5	3	1
6	3	1
7	5	2
8	5	2
9	5	3
10	7	3
11	7	3
12	7	3
13	9	6
14	9	6
15	9	7
16	11	7
17	11	8
18	11	7
19	13	11
20	13	10
21	13	12
22	15	13
23	15	15
24	15	17
25	17	19
26	17	18
27	17	19
28	19	20
29	19	23
30	19	22
31	21	24
32	21	23
33	21	24

34	23	25
35	23	26
36	23	27

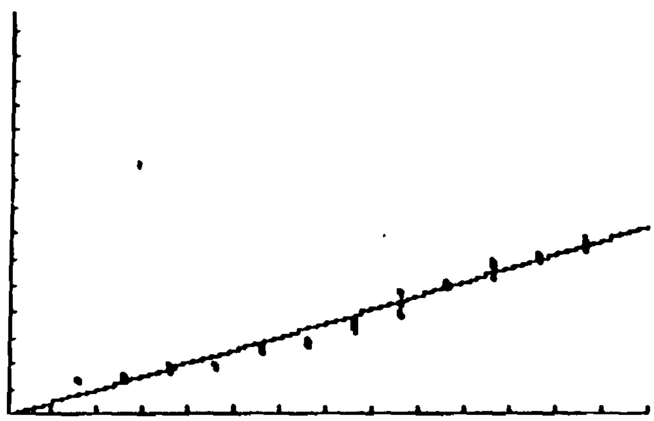
ELF SCATTER MODULE
DATABASE: WHITING VIS.ASS.(EEC).

INDEPENDENT VARIABLE (X): DAYS-ICE
DEPENDENT VARIABLE (Y): DM.PTS.

CORRELATION COEFFICIENT .98253
R SQUARED .9653
T STATISTIC 30.78735
INTERCEPT (A) -4.142
SLOPE (B) 1.2873
STD ERROR OF ESTIMATE 1.73207

OBSERVATIONS 36
Y: DM.PTS. X: DAYS-ICE
YMIN -28 YMAX 51 YINC 5
XMIN -1.9 XMAX 25.9 XINC 2

]



?SYNTAX ERROR
]PR#6ELF PRINT MODULE
DATABASE: WHITING VIS.ASS.(FIL)

OBS	DAYS-I	DM.PTS
1	1	0
2	3	1
3	5	3
4	7	4
5	9	9
6	11	13
7	13	15
8	15	16
9	17	18
10	19	21
11	21	24
12	23	26

ELF SCATTER MODULE
DATABASE: WHITING VIS.ASS.(FIL).

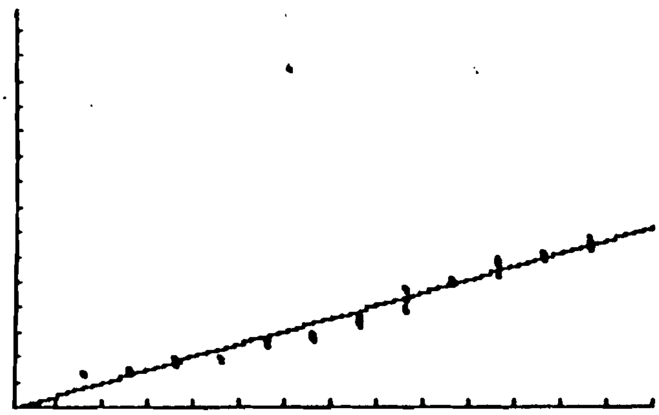
INDEPENDENT VARIABLE (X): DAYS-ICE
DEPENDENT VARIABLE (Y): DM.PTS.

INDEPENDENT VARIABLE (X): DAYS-ICE
DEPENDENT VARIABLE (Y): DM.PTS.

CORRELATION COEFFICIENT .98253
R SQUARED .9653
T STATISTIC 30.78735
INTERCEPT (A) -4.142
SLOPE (B) 1.2873
STD ERROR OF ESTIMATE 1.73207

OBSERVATIONS 36
Y: DM.PTS. X: DAYS-ICE
YMIN -28 YMAX 51 YINC 5
XMIN -1.9 XMAX 25.9 XINC 2

]



?SYNTAX ERROR
]PR#6ELF PRINT MODULE

DATABASE: WHITING VIS.ASS.(FIL).

OBS	DAYS-I	DM.PTS
1	1	0
2	3	1
3	5	3
4	7	4
5	9	9
6	11	13
7	13	15
8	15	16
9	17	18
10	19	21
11	21	24
12	23	26

ELF SCATTER MODULE
DATABASE: WHITING VIS.ASS.(FIL).

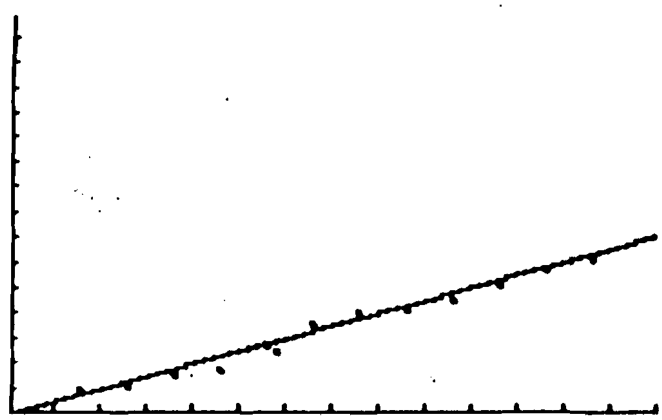
INDEPENDENT VARIABLE (X): DAYS-ICE
DEPENDENT VARIABLE (Y): DM.PTS.

CORRELATION COEFFICIENT .99289
R SQUARED .9858
T STATISTIC 26.38123
INTERCEPT (A) -2.43706
SLOPE (B) 1.24476
STD ERROR OF ESTIMATE 1.12846

SLOPE (B) 1.24476
STD ERROR OF ESTIMATE 1.12846

OBSERVATIONS 12
Y: DM.PTS.   X: DAYS-ICE
YMIN -27   YMAX 52   YINC 5
XMIN -1.9   XMAX 25.9   XINC 2

]



?SYNTAX ERROR

[illegible]
2°-6° (average)

TREATMENT Ungutted & gutted whole fish DATE Caught [illegible] REMOVAL

FISH IDENT. Blue Grenadier

Attribute		Scale	1st Removal (Day 1)	2nd Removal	3rd Removal (Day 5)	4th Removal (Day 8)	5th Removal	6th Removal	7th Removal	8th Removal (Day 13)	9th Removal (Day 15)	10th Removal	11th Removal (Day 1?)	12th Removal (Day 21)		
FISH			F1 F2 F3 F4	F1 F2 F3 F4	F1 F2 F3 F4	F1 F2 F3 F4	F1 F2 F3 F4	F1 F2 F3 F4	F1 F2 F3 F4	F1 F2 F3 F4	F1 F2 F3 F4	F1 F2 F3 F4	F1 F2 F3	F1 F2		
APPEARANCE		(V.Bright/Bright/Sl.Dull/Dull) 0 1 2 3	0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	1 1 2 1	2 2 1 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2	3 3	–	–
SKIN		(Firm/Soft) 0 1	0 0 0 0	0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1	1 1	–	–
SCALES		(Firm/Sl.Loose/Loose) 0 1 2	0 0 0 0	0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1	1 1	–	–
SLIME		(Absent/Sl.Slimy/Slimy/V.Slimy) 0 1 2 3	0 0 0 0	1 0 1 0	1 1 1 1	1 1 1 1	1 1 1 1	1 2 1 1	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	3 3 3	1 3	–	–
STIFFNESS		(Pre-Rigor/Rigor/Post-Rigor) 0 1 2	1 1 1 1	1 2 2 1	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2	2 2	–	–
EYES	Clarity	(Clear/Sl.Cloudy/Cloudy) 0 1 2	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 2	1 1 1 2	1 1 2 2	2 2 2	2 2	–	–
	Shape	(Normal/Sl.Sunken/Sunken) 0 1 2	0 0 0 0	0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 2 1 2	1 1 2 2	2 2 2 2	2 2 2	2 2	–	–
	Iris	(Visible/Not Visible) 0 1	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 1	0 0 1 0	0 0 1 1	1 1 1	1 1	–	=
	Blood	(No Blood/Sl.Bloody/V.Bloody) 0 1 2	0 1 1 1	1 1 1 1	1 1 1 1	1 1 1 2	1 1 1 1	1 1 2 2	1 1 1 1	1 1 1 2	1 2 1 1	2 1 2 1	1 2 2	2 1	–	–
GILLS	Colour	Characteristic (Sl.Dark) (V.Dark) (Sl.Faded) (V.Faded) 0 1 2	0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	1 1 1 2	1 2 1 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2	2 2	–	–
	Mucous	(Absent/Moderate/Excessive) 0 1 2	0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 2 1	2 2	–	–
	Smell	(Fresh Oily) (Metallic, Seaweed) Fishy/Stale/Spoilt 1 2 3	0 0 0 0	0 1 0 1	1 1 1 1	1 2 1 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 3 3	3 3	–	–
BELLY	Discoloration	(Absent/Detectable/Moderate/Excessive) 0 1 2 3	0 0 0 0	0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	1 1 1 1	1 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2	2 3	–	–
	Firmness	(Firm/Soft/Burst) 0 1 2	0 0 0 0	0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1	1 1	–	–
VENT	Condition	Normal (Sl.Break) (Exudes) (Excessive) (Opening) 0 1 2	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1	2 2	–	–
	Smell	(Fresh/Neutral/Fishy/Spoilt) 0 1 2 3	0 0 0 0	1 0 1 1	1 1 1 1	1 1 1 1	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 3 3	3 3	–	–
BELLY CAVITY	Stains	(Opalescent/Greyish/Yellow-Brown) 0 1 2	0 0 0 0	0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1	1 1	–	–
	Blood	(Red/Dark Red/Brown) 0 1 2	0 0 0 0	0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 2	1 2	–	–
Total Demerit Score	Ungutted		2 3 3 3	5 5 6 5	10 10 10 10	15 16 15 17	18 18 19 19	19 21 19 21	21 22 22 22	22 21 21 23	25 23 22 23	24 24 26 28	28 30 30	32 33	–	–
	Gutted		2 3 3 3	5 5 6 5	10 10 10 10	17 18 17 19	20 20 21 21	21 23 21 23	23 24 24 26	24 24 25 25	27 24 24 27	24 25 28 28	28 32 32	34 35		
Average Score	Ungutted		(3)	(5)	(10)	(16)	(19)	(20)	(22)	(23)	(24)	(25)	(29)	(33)		
	Gutted		(3)	(5)	(10)	(18)	(21)	(22)	(24)	(25)	(26)	(27)	(31)	(35)		

DEMERIT SCORE SHEET FOR FILLETED SAMPLES

TREATMENT Fillets (Tunnel) DATE REMOVAL	17/8/84	18/8/84	20/8/84	22/8/84	23/8/84	24/8/84	25/8/84	26/8/84	27/8/84	28/8/84	31/8/84	4/9/84
FISH IDENT. Blue Grenadier	N_3	D_4	G_6	L_8	S_9	R_{10}	K_{11}	T_{12}	U_{13}	P_{14}	M_{17}	O_{21}
1. EASE OF FILLETING : (Easy 0 / sl. difficult 1 / difficult 2)	-	-	-	-	-	-	-	-	-	-	-	-
2. APPEARANCE : (a) Colour of flesh : (Translucent 0 / sl. discoloured 1 / sl. opaque 2 / opaque 3)	0	0	1	1 (sl. diffused)	1	1	1	2	2	2	2 (opaque at belly flap)	3
(b) Blood stains : (Absent 0 / Detectable 1 / Moderate 2 / Excessive 3)	1 (slight diffused)	(belly flap)	1 (diffused)	1 (diffused)	1 (1 big clot)	2	2	2	2	2	3 (mostly along lateral line)	3
(c) Clotting (Unclotted 0 / sl. clotted 1 / moderately clotted 2 / Excessively clotted 3)	0	0	0	0	1	1	1 (at lateral line)	1 (tiny ...)	(... clot and diffused)	2 (3 small ...)	2 (esp. along lateral line)	2
(d) Skin Colour : (v. bright 0 / bright 1 / sl. dull 2 / dull 3)	0	1	1	1	2	2	2	2	2	2	2	3
3. TEXTURE : (Firm 0 / sl. soft 1 / soft 2)	0	0	0	1	1 (sl. soft)	1	1 (sl. soft)	1	1	1	2 (flabby)	2 (flabby)
4. ODOUR : (Fresh 0 / Neutral 1 / Stale 2 / Spoilt 3)	0	1	1	1	1	1	1	1	2 (fishy)	2 (fishy)	2 (fishy)	3 (...)
5. CONDITION : (a) Gaping : (Absent 0 / Detectable 1 / Moderate 2 / Excessive 3)	0	0	0	1	1	1	1	2	2	2	2	3
(b) Bruising : (Absent 0 / Slight 1 / Severe 2)	0	0	1	1	1	1	1	1	1 (moderate)	1	2 (at lateral line)	2
(c) Wetness : (Normal 0 / sl. dry or sl. drip 1 / moderately dry or moderate drip 2 / Excessive dryness or freezer burn or excessive drip 3)	0	0	1	1	1	1	1	2	2	2	2 (moderate)	3
(d) Autolysis (Discolourations) : (Absent 0 / moderate 1 / severe 2)	0	0	0	0	0	0	1 (detectable)	1	1 (yellowish brown at belly flap)	1 (brownish at belly flap)	1 (yellow brownish at belly flap)	2 (yellowish green)
(e) Parasites Infestations : (Absent 0 / Moderate 1 / severe 2)	0	0	0	0	0	0	0	0	0	0	0	0
(f) Other Discolourations or Contaminants (bones, membranes, tissues etc.) (absent 0 / present 1)	0	0	0	0	0	0	1 (little brown at belly flap)	1	1	1	1	1
6. EASE OF SKINNING (Easy 0 / sl. difficult 1 / difficult 2)	0	0	0	0	0	1	1	1	1	1	2	2
TOTAL (...)	1	2	6	8	10	12	14	17	18	19	23	29
PH	6.60 6.62 6.60	6.58 6.58 6.58	6.61 6.62 6.63	6.51 6.57 6.69	6.53 6.57 6.54	6.57 6.57 6.67	6.71 6.57 6.53	6.53 6.56 6.66	6.51 6.56 6.66	6.71 6.86 6.99	7.00 6.90 6.76	6.68 6.70 6.96
	6.61	6.58	6.62	6.59	6.55	6.60	6.61	6.65	6.58	6.85	6.89	6.74

DEMERIT SCORE SHEET FOR FILLETED SAMPLES

TREATMENT FILLETS (THAWED) DATE 24/8/84 REMOVAL

FISH IDENT. WHITINGS	24/8/84 O_1	26/8/84 M_3	27/8/84 D_5	30/8/84 G_7	1/9/84 T_9	3/9/84 S_{11}	5/9/84 N_{13}	7/9/84 R_{15}	9/9/84 P_{17}	11/9/84 U_{19}	13/9/84 L_{21}	15/9/84 K_{23}
EASE OF FILLETING : (Easy 0 / sl. difficult 1 / difficult 2)	0	0	0	0	1	1	1	1	1	2	2	2
APPEARANCE : (a) Colour of flesh : (Translucent 0 / sl. discoloured 1 / sl. opaque 2 / opaque 3)	0 [illegible]	0	0	0	1	1	1	1	2	2 light yellow	2 yellow-brown	3 distinct yellow flesh
(b) Blood stains : (Absent 0 / Detectable 1 / Moderate 2 / Excessive 3)	0	0	0	0	1	1	1	1	1	1	2	2
(c) Clotting : (Unclotted 0 / sl. clotted 1 / moderately clotted 2 / Excessively clotted 3)	0	0	0	0	0	0	1	1 along [illegible] column	1	1	1	2
(d) Skin Colour : (v. bright 0 / bright 1 / sl. dull 2 / dull 3)	0	1	1	1	2	2	2	2	3	3	3	3
TEXTURE : (Firm 0 / sl. Soft 1 / soft 2)	0	0	0	0	1	1	1	1	1	1	2 friable	2 friable
ODOUR : (Fresh 0 / Neutral 1 / Stale 2 / Spoilt 3)	0	0	0	1	1	2	2	2	2	3	3	3
CONDITION : (a) Gaping : (Absent 0 / Detectable 1 / Moderate 2 / Excessive 3)	0	0	1	1	1	2	2	2	2	2	2	2
(b) Bruising : (Absent 0 / Slight 1 / Severe 2)	0	0	0	0	0	0	1	1	1	1	1	1
(c) Wetness : (Normal 0 / sl. dry or sl. drip 1 / moderately dry or moderate drip 2 / Excessive dryness or Freezer burn or Excessive drip 3)	0	0	1	1	1	1	1	2	2	2	3	3
(d) Autolysis (Discolouration) : (Absent 0 / moderate 1 / severe 2)	0 belly flap [illegible]	0	0	0	0	1 light brown on flesh	1 light brown on flesh	1 light brown on flesh	1 light brown patches	2 browning at belly flap	2 browning of flesh	2 browning of flesh
(e) Parasites 2. [illegible] : (Absent 0 / Moderate 1 / severe 2)	0	0	0	0	0	0	0	0	0	0	0	0
(f) Other Discolouration or Contamination (bones, membranes, tissue etc.) skins : (absent 0 / present 1)	0	0	0	0	0	1 light brown	1 light brown	1 light brown	1 light brown patches	1 light brown patches	1 light brown [illegible]	1 light brown [illegible]
EASE OF SKINNING (Easy 0 / sl. difficult 1 / difficult 2)	–	–	–	–	–	–	–	–	–	–	–	–
TOTAL	0	1	3	4	9	13	15	16	18	21	24	26
pH	6.75 6.67 6.75	6.64 6.69 6.67	6.70 6.79 6.79	6.70 6.74 6.72	6.78 6.78 6.81	6.72 6.77 6.81	6.80 6.82 6.82	7.08 7.14 7.13	7.13 6.95 6.94	7.63 7.64 7.52	8.13 8.18 8.15	7.89 7.89 7.89
	6.72	6.67	6.76	6.72	6.78	6.77	6.81	7.12	7.01	7.53	8.15	7.89

FISH: WHITINGS Treatment: iced & kept at 0°C TG 34 EEC SCORE SHEET Time: 2.00 - 2.30 p.m.

	Body Part	DAY 1 24/8/84			DAY 3 26/8/84			DAY 5 28/8/84			DAY 7 30/8/84			DAY 9 1/9/84			DAY 11 3/9/84			DAY 13 5/9/84			DAY 15 7/9/84			DAY 17 9/9/84			DAY 19 11/9/84			DAY 21 13/9/84			DAY 23 15/9/84		
		w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3
APPEARANCE	SKIN	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3
	EYES	0	0	0	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	2	1	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3
	GILLS	0	0	0	0	0	0	1	0	1	1	1	1	2	1	1	2	1	1	1	1	1	2	2	2	3	2	2	2	3	3	3	2	3	3	3	3
	MUSCULAR FLESH OR TISSUE	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	2	3	3	3
	COLOURATION ALONG VERTEBRAL COLUMN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	ORGANS	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
CONDITION	MUSCULAR FLESH OR TISSUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3
	BACKBONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	2	1	1	1	1	2
	PERITONEUM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	2	1	2	2	2	2	2	2	2	2	2	3	2	2	3	3
SMELL	SKIN, GILLS & BODY CAVITY	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	TOTAL SCORE	0	0	0	0	1	1	2	2	3	3	3	3	6	6	7	7	8	7	11	10	12	13	15	17	19	18	19	20	23	22	24	23	24	25	26	27
	AVERAGE	(0)			(1)			(2)			(3)			(6)			(7)			(11)			(15)			(19)			(22)			(24)			(26)		

(At 0°C) Scoring taken at 2.00 - 2.30 P.M.

TREATMENT TG34 BASE REMOVAL

FISH IDENT. Blue Rock Whiting (Haletta semifasciata)

			24/8/84 DAY 1			26/8/84 DAY 3			28/8/84 DAY 5			30/8/84 DAY 7			1/9/84 DAY 9			3/9/84 DAY 11			5/9/84 DAY 13			7/9/84 DAY 15			9/9/84 DAY 17			Tuesday 11/9/84 DAY 19			Thurs 13/9/84 DAY 21			Sat. 15/9/84 DAY 23		
			w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3	w_1	w_2	w_3
APPEARANCE		(V.Bright/Bright/Sl.Dull/Dull) 0 1 2 3	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
SKIN		(Firm/Soft) 0 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
SCALES		(Firm/Sl.Loose/Loose) 0 1 2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
SLIME		(Absent/Sl.Slimy/Slimy/V.Slimy) 0 1 2 3	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3
STIFFNESS		(Pre-Rigor/Rigor/Post-Rigor) 0 1 2	1	1	1	1	1	1	1	1	1	1-2	1	1-2	1	1-2	1-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
EYES	Clarity	(Clear/Sl.Cloudy/Cloudy) 0 1 2	0	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2
	Shape	(Normal/Sl.Sunken/Sunken) 0 1 2	0	0	0	0	0	1	1	0	1	1	0	0	0	1	1	1	1	1	2	1	1	2	1	1	2	2	2	2	2	2	2	2	2	2	2	2
	Iris	(Visible/Not Visible) 0 1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1
	Blood	(No Blood/Sl.Bloody/V.Bloody) 0 1 2	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	1	1	0	0	0	1	1	1	0	0	0	0	1	1	1	1	1	1	1
GILLS	Colour	Characteristic (Sl.Dark) (Sl.Faded) (V.Dark) (V.Faded) 0 1 2	0	0	0	0	0	0	1	0	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	2	2	1	2	1	2	2	2	1	2	2	1	2
	Mucus	(Absent/Moderate/Excessive) 0 1 2	0	0	0	0	0	0	1	1	1	1	1	1	2	1	1	1	1	1	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Smell	(Fresh Oily) (Metallic, Seaweed) Fishy/Stale/Spoilt 1 2 3	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
BELLY	Discoloration	(Absent/Detectable/Moderate/Excessive) 0 1 2 3	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	3	2	2	3	3	3	2	3	2	3	3	3	3	3
	Firmness	(Firm/Soft/Burst) 0 1 2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2
VENT	Condition	Normal (Sl.Break) (Excessive) (Tender) (Opening) 0 1 2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	1	1	1	1	1	1	1	1	1	2	1	1	1	1	2
	Smell	(Fresh/Neutral/Fishy/Spoilt) 0 1 2 3	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3
* BELLY CAVITY	Stains	(Opalescent/Greyish/Yellow-Brown) 0 1 2	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2
	Blood	(Red/Dark Red/Brown) 0 1 2	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
TOTAL DEMERIT SCORE		Ungutted	1	1	1	1	2	2	4	3	5	7-8	7	7-8	13	14-15	12-13	16	14	15	20	16	20	24	24	25	29	29	30	30	30	32	33	32	32	32	32	34
		Gutted	1	1	1	1	2	2	4	3	5	9-10	9	9-10	15	16-17	14-15	18	16	17	22	18	22	26	27	28	32	32	33	34	34	36	37	36	36	36	36	38
AVERAGE		Ungutted	(1)			(2)			(4)			(7)			(13)			(15)			(19)			(24)			(29)			(31)			(32)			(33)		
		Gutted	(1)			(2)			(4)			(9)			(15)			(17)			(21)			(27)			(32)			(35)			(36)			(37)		

Fish : Blue Grenadier (ungutted)

# EEC SCORE SHEET (Demerit System)
max = pt: 30

Date fish caught : 8.00 a.m. 15/8/84

		DAY 3 12.00 noon 17/8/84	DAY 4 4.00 noon 18/8/84	DAY 6 4.00 p.m. 20/8/84	DAY 8 9.20 a.m. 22/8/84	DAY 9 9.20 a.m. 23/8/84	DAY 10 7.20 a.m. 24/8/84	DAY 11 2.00 p.m. 25/8/84	DAY 12 2.00 p.m. 26/8/84	DAY 13 10.00 a.m. 27/8/84	DAY 14 28/8/84	DAY 17 31/8/84	DAY 21 4/9/84
	Body Part	F_1 F_2 F_3 F_4	F_1 F_2 F_3 F_4	F_1 F_2 F_3 F_4	F_1 F_2 F_3 F_4	F_1 F_2 F_3 F_4	F_1 F_2 F_3 F_4	F_1 F_2 F_3 F_4	F_1 F_2 F_3 F_4	F_1 F_2 F_3 F_4	F_1 F_2 F_3 F_4	F_1 F_2 F_3 F_4	F_1 F_2
APPEARANCE	SKIN	0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	1 1 2 1	2 2 1 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	3 3 – –
	EYES	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	2 2 2 2	2 2 2 2	2 2 2 2	2 2 3 2	3 2 2 3	3 3 3 3	3 3 3 3	3 3 – –
	GILLS	0 0 0 0	0 0 0 0	1 1 1 1	1 2 1 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 3 3 3	3 3 – –
	MUSCULAR FLESH OR TISSUE	0 0 0 0	0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	1 1 1 1	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 3 2 2	2 3 – –
	COLOURATION ALONG VERTEBRAL COLUMN	0 0 0 0	0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	2 2 2 2	2 2 2 2	2 2 2 2	2 3 2 2	3 3 – –
	ORGANS	0 0 0 0	0 1 0 0	1 1 1 1	1 1 1 1	2 1 1 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 – –
CONDITION	MUSCULAR FLESH OR TISSUE	0 0 0 0	0 1 1 0	1 1 1 1	1 1 1 1	1 1 2 2	1 2 1 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 3 – –
	BACKBONE	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 – –
	PERITONEUM	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 1 0 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 2 – –
SMELL	SKIN, GILLS & BODY CAVITY	0 0 0 0	0 1 1 0	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	2 2 2 2	2 2 2 2	2 2 2 2	2 3 3 2	3 3 – –
	TOTAL SCORE	1 1 1 1	1 4 3 1	6 6 6 6	8 9 8 9	10 11 12 12	12 14 11 14	15 15 15 15	17 18 19 18	19 18 18 19	19 19 19 19	19 23 21 20	23 26 – –
	* AVERAGE TOTAL SCORE	(1)	(2)	(6)	(9)	(11)	(13)	(15)	(18)	(19.5)	(19)	(21)	(25)

Other Occasional Papers in the series:

1. A salinity monitor for irrigation pumps, by E.O.MIEZITIS.

2. Wine, liqueur and fish products acceptability trials 47th ANZAAS Congress, Hobart, 1976, by H.A.BREMNER, T.L.LEWIS and A.R.QUARMBY.

3. Abalone silage: an exercise in the conservation of waste, by JUNE OLLEY.

4. Course notes contributed by the CSIRO Tasmanian Food Research Unit to a workshop on fish handling and quality control, Hobart Oct.3rd-5th, 1978, by H.A.BREMNER, JUNE OLLEY and S.J.THROWER.

5. Difficulties with generalized least squares regression in forest modelling, by P.W.WEST.

6. Metabolism of zinc, cadmium and copper in rats fed shellfish highly contaminated with heavy metals, by S.J.THROWER, JUNE OLLEY and MAUREEN McDERMOTT.

7. Hygiene control in seafood processing, by S.J.THROWER.